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ABSTRACT

This biology guide, for use at the secondary level, is one of a series of guides, K-12, which were developed by teachers to help introduce environmental education into the total curriculum. The guides are supplementary in design, containing a series of episodes (minilessons) that emphasize experimentation and discussion relating to environmental problems making science more relevant to the student. The episodes are built around 12 major environmental concepts that form a framework for each grade or subject area, as well as for the entire K-12 program. Although the same concepts are used throughout the K-12 program, emphasis is placed on different aspects of each concept at different grade levels or in different subject areas. This guide focuses on aspects such as photosynthesis, the food chain, and the watercycle. The 12 concepts are covered in one of the episodes contained in the guide. Further, each episode offers subject area integration, subject area activities, interdisciplinary activities, cognitive and affective behavioral objectives, and suggested references and resource materials useful to teachers and students. (Author/TK)

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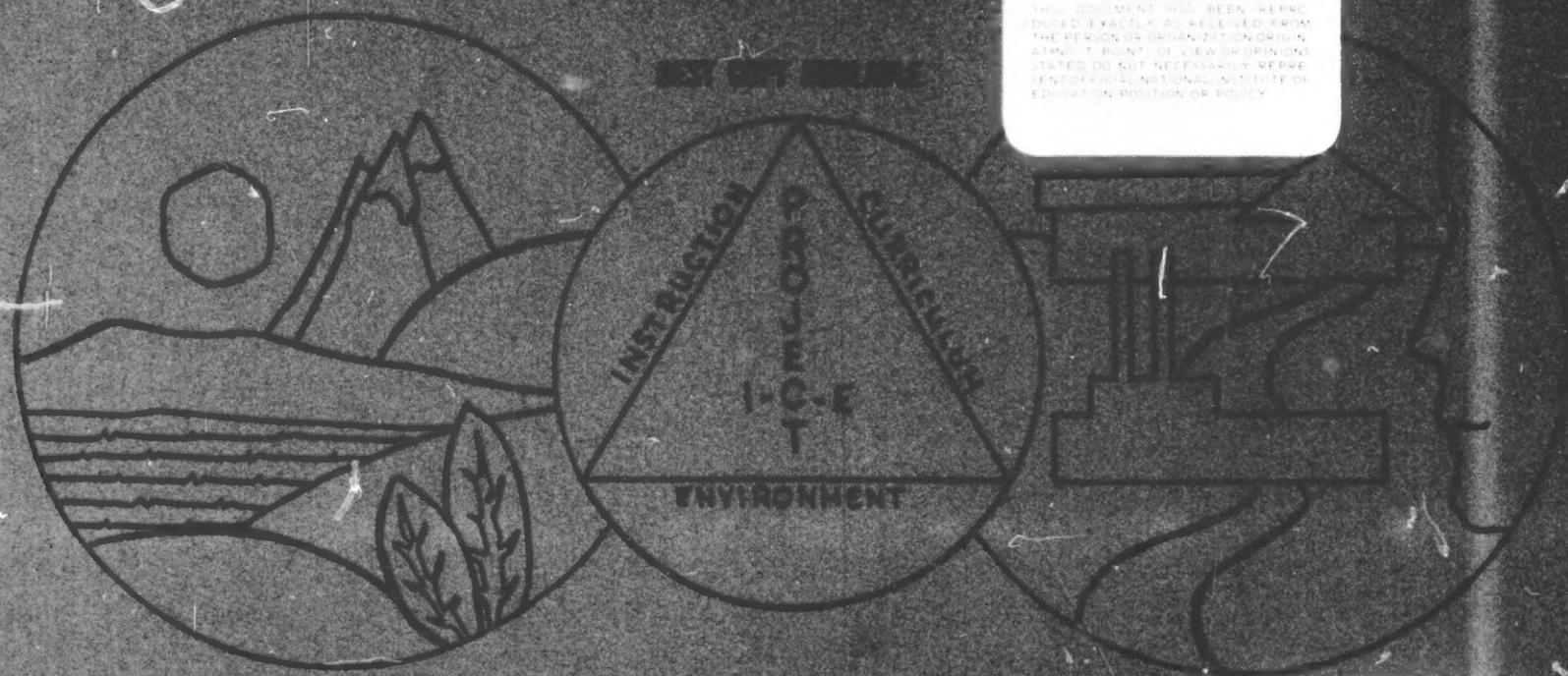
ENVIRONMENTAL EDUCATION GUIDE



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FORWARD TO PROJECT I-C-E ENVIRONMENTAL EDUCATION GUIDES

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In 1969, the First Environmental Quality Education Act was proposed in the United States Congress. At the time of the introduction of that legislation, I stated:

"There is a dire need to improve the understanding by Americans of the ominous deterioration of the Nation's environment and the increasing threat of irreversible ecological catastrophe. We must all become stewards for the preservation of life on our resource-deficient planet."

In the three years since the Environmental Education Act was passed by the Congress, much has happened in the United States to reinforce the great need for effective environmental education for the Nation's young people. The intensive concern over adequate energy resources, the continuing degradation of our air and water, and the discussion over the economic costs of the war against pollution have all brought the question of the environmental quality of this nation to a concern not merely of aesthetics but of the survival of the human race.

The intense interest by the public in the quality of our lives as affected by the environment clearly indicates that we cannot just use incentives and prescriptions to industry and other sources of pollution. That is necessary, but not sufficient." The race between education and catastrophe can be won by education if we marshall our resources in a systematic manner and squarely confront the long-term approach to saving our environment through the process of education.

As the incessant conqueror of nature, we must reexamine our place and role. Our world is no longer an endless frontier. We constantly are feeling the backlash from many of our ill-conceived efforts to achieve progress.

Rachel Carson's theme of "reverence for life" is becoming less mystical and of more substance as our eyes are opened to much of the havoc we have wrought under the guise of progress. A strong commitment to an all-embracing program of environmental education will help us to find that new working definition of progress that is a pre-requisite to the continued presence of life on this planet.

- Senator Gaylord Nelson

BIOLOGY PREFACE

Today's young person in secondary science education is searching for the answer to a very basic question: Why take science? Specifically, the student wants to know how science education relates to his life. Certainly, experimentation and discussion pertaining to environmental problems provide an excellent opportunity for science educators to make pure science topics more relevant to students.

This booklet is divided into twelve major areas, each dealing with a major environmental concept. The purpose of this environmental booklet is not to replace your present course of study, but rather to supplement existing class activities with worthwhile environmental topics. Also, the booklet attempts to point out how some of your teaching activities can be related to environmental education. An example of this might be how microbiological experimentation can be used in the study of air quality. In effect, this booklet will build student awareness of environmental problems as well as make science education more meaningful to them.

*NOTE: Advanced Biology Activites are included in this book - See separate table of contents.

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DIRECTIONS FOR USING THIS GUIDE

This guide contains a series of episodes (mini-lesson plans), each containing a number of suggested in and out of class learning activities. The episodes are built around 12 major environmental concepts that form a framework for each grade or subject area, as well as for the entire K-12 program. Further, each episode offers subject area integration, multi-disciplinary activities, where applicable, both cognitive and affective behavioral objectives and suggested reference and resource materials useful to the teacher and students.

1. This I-C-E guide is supplementary in design--it is not a complete course of study, nor is its arrangement sequential. You can teach environmentally within the context of your course of study or units by integrating the many ideas and activities suggested.

2. The suggested learning activities are departures from regular text or curriculum programs, while providing for skill development.

3. You decide when any concepts, objectives, activities and resources can conveniently be included in your unit.

4. All episodes can be adapted, modified, or expanded thereby providing great flexibility for any teaching situation.

5. While each grade level or subject area has its own topic or unit emphasis, inter-grade coordination or subject area articulation to avoid duplication and overlap is highly recommended for any school or district seeking effective implementation.

This total K-12 environmental education series is the product of 235 classroom teachers from Northeastern Wisconsin. They created, used, revised and edited these guides over a period of four years. To this first step in the 1,000 mile journey of human survival, we invite you to take the second step--by using this guide and by adding your own inspirations along the way.

PROJECT I-C-E TWELVE MAJOR ENVIRONMENTAL CONCEPTS

1. The sun is the basic source of energy on earth. Transformation of sun energy to other energy forms (often begun by plant photosynthesis) provides food, fuel and power for life systems and machines.

2. All living organisms interact among themselves and their environment, forming an intricate unit called an ecosystem.

3. Environmental factors are limiting on the numbers of organisms living within their influence. Thus, each ecosystem has a carrying capacity.

4. An adequate supply of clean water is essential to life.

5. An adequate supply of clean air is essential for life.

6. The distribution of natural resources and the interaction of physical environmental factors greatly affect the quality of life.

7. Factors such as facilitating transportation, economic conditions, population growth and increased leisure time influence changes in land use and population densities.

8. Cultural, economic, social, and political factors determine man's values and attitudes toward his environment.

9. Man has the ability to manage, manipulate and change his environment.

10. Short-term economic gains may produce long-term environmental losses.

11. Individual acts, duplicated or compounded, produce significant environmental alterations over time.

12. Each person must exercise stewardship of the earth for the benefit of mankind.

A "Concept Rationale" booklet and a slide/tape program "Man Needs His Environment" are available from the I-C-E RMC to more fully explain these concepts.

BIOLOGY

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Environmental: Integrated with:

CONCEPT NO. 1 - Energy SUBJECT Biology

ORIENTATION Energy Use TOPIC/UNIT Photosynthesis

BEHAVIORAL OBJECTIVES

Cognitive:

Demonstrate by experiment that plant organisms are dependent on sun energy for photosynthesis.

Affective:

Accept the fact that plant photosynthesis is the major chemical process supplying energy for life without challenge.

Skills Used:

Culture a group of plant organisms.
Construct an artificial atmosphere (leave to student's imagination).
Measure growth rate in plants.
Scientific investigation.
Utilization of Manometer or volumeter apparatus.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. By use of a volumeter or manometer students can determine the effects of varying light intensities on the rate of photosynthesis. (BSCS BLUE: 2nd Ed, p. 174.) It is not necessary to purchase a manometer since it can be easily made by students. (Fig. 1)
2. Students using bromthymol blue and elodes will demonstrate the relationship between light and photosynthesis. (BSCS BLUE: 2nd Ed. p. 168.)
3. Student team should set up a plant-growth experiment where one group is subjected to sun energy directly while another is subjected to a filter device so that sunlight of the same intensity does not reach the plants. Differences in growth rate should be evident.
4. Identify various plants which are shade tolerant or which are shade intolerant. Grow samples of various household plants, some of which are shade tolerant and some which prefer shaded areas.

Outside or Community:

1. Use the school area to observe signs of subdued growth because of blocking out of sunlight. Observe shaded growth areas as compared to open sunlight areas. Identify shade tolerant plants.
2. If possible, use wooded areas to compare vegetation on edges, in meadows, and in areas of least sunlight.
3. If possible, visit large greenhouse to observe methods of use of sunlight and means of controls for maximum growth of plants.

SUGGESTED RESOURCES

Publications:

Any Biology text should discuss role of sunlight in photosynthesis.
High School Biology - Green Version, BSCS, 2nd edition.
Modern Biology, Otto, Towle, 1969, Ch. 26, Ch. 50.
Any ecology text should discuss air pollution as filtering out sunlight.
Biological Science: Molecules to Man, Blue Version, BSCS, 2nd ed.

Audio-Visual:

Film:
Photosynthesis: Chemistry of Food Making, BAVI.
Film Loop:
BSCS Loop: Engelmann's Inquiry Into Photosynthesis,
BSCS Loop: Structure of a Green Plant.

Special Equipment:
Volumeter or Manometer.

Community:

Forestry representative.
Florist - class visit or talk.

CONTINUED OR ADDED LEARNING ACTIVITIES

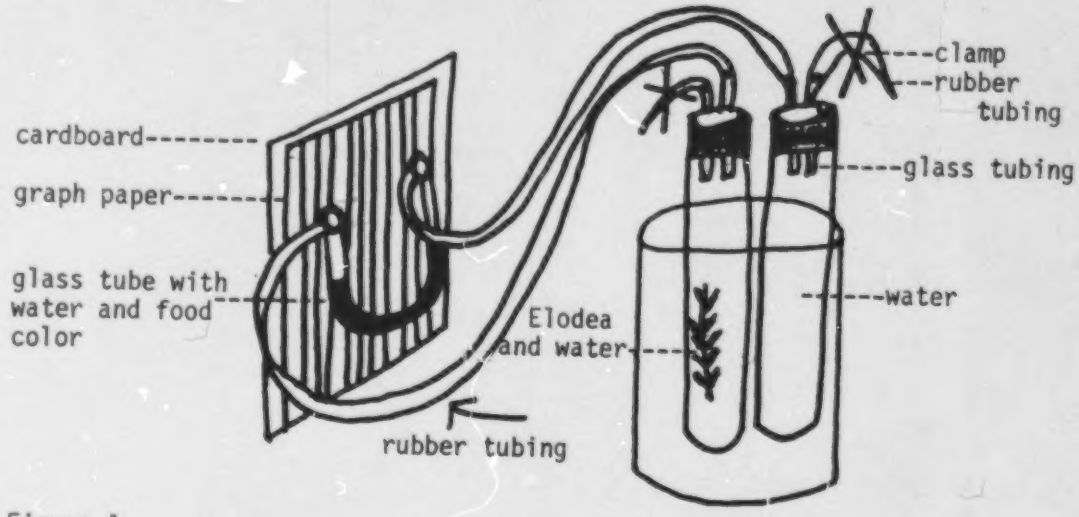

Figure 1.

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Environmental:

Integrated with:

CONCEPT NO. 1 - Energy

SUBJECT Biology

ORIENTATION Energy Use

TOPIC/UNIT Photosynthesis

E. S. E. A. Title III – PROJECT I-C-E 59-70-0135-4

BEHAVIORAL OBJECTIVES

Cognitive:

Determine areas where starch has been produced in leaves as a result of photosynthesis. Explain what would happen to the process of photosynthesis in a given plant if energy were to be stopped to the plant.

Affective:

Verify the importance of light in food production by plants by experiment.

Skills Used:

Scientific investigation. Comparison of results and producing these on drawings.

STUDENT-CENTERED LEARNING ACTIVITIES

In-Class:

1. Lab Demonstration: Photosynthesis - Obtain two small coleus or geranium plants in pots. Place one in dark for 24 hours. Leave other plant in direct sunlight for at least one hour before experiment. Also, a geranium plant may be placed in the dark for 36 hours, then place light screen, black paper, on both sides of leaf with a cut out area on top surface in front of a lamp for 12 hours. (Fig. 2)

Fig. 2

Remove one leaf from each plant and mark to tell apart. Place each of them in a beaker containing alcohol and boil until the chlorophyll is removed.

(Continued)

Outside or Community:

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES

Publications:

Modern Biology, Ch. 6.
High School Biology - BSCS, Green Version.
Interaction of Man & Biosphere, ISC Project, P. 25-27, Investigation 2.1.

Audio-Visual:

Geranium or coleus plant.
Alcohol
Iodine
Beaker
Hot plate

Community:

CLASSROOM: (Continued)

Remove leaves, rinse with water, flood each with iodine. Rinse again with water and observe color of leaves. A dark blue-black color indicates the presence of starch food made by the leaf. Draw both leaves and shade areas where starch has been produced.

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Environmental: **Integrated with:**

CONCEPT NO. 2 - Ecosystem SUBJECT Biology

ORIENTATION Community/environment interaction TOPIC/UNIT Ecosystems

BEHAVIORAL OBJECTIVES

Cognitive:

1. Properly demonstrate making a soil profile.
2. Determine the importance of the make-up of soil as to productivity by identifying several poor soil conditions.
3. Explain the influence of bedrock geology on the soil community by correlating parent matter contributions with

(Continued)

Affective:

1. Suggest the effects of several environmental factors on the numbers and species composition of the soil ecosystem.
2. Study a soil community and observe the diversity of invertebrate life in a common biotic community, upon completion of this investigation.

Skills Used:

Procedures for investigating soils.
Collecting soil organisms.
Computation.
Manipulating apparatus.
Identification of invertebrate orders and classes. (Continued)

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Make a soil profile.
   a. To become familiar with a soil profile, make a vertical cut through a well drained soil, being careful so as not to select an area where debris and fill has been added to the surface soil.
   b. Observe the depth of the various horizons, color, texture, and pH.
   c. Measure the pH of the 3 major horizons with a soil pH test kit. Record differences and explain what it indicates.
   d. Sketch the soil profile, show horizons, depths, color and pH.
   e. Similar cuts may be made in other areas, perhaps a woods, then a comparison can be made.
2. Study Regional Geology.
   a. Read about the bedrock geology of the regior in a good reference book for your area.

(Continued)

Outside or Community:

SUGGESTED RESOURCES

Publications:

BSCS Green Version High School Biology, Chapters 3 and 4.
Standard Biology Text-Sections on Invertebrate animals and on Ecology.
Taxonomic Keys to the Common Animals of the North Central States, Eddy and Hodson, Burgess Publishing.
How to Know the Insects! Jacques, W. C. Brown Company.
What Insect is That? American Ed. Center, Columbus, Ohio, $.40.
The Nature and Property of Soils, Buckman & Brady, MacMillan.

(Continued)

Audio-Visual:

New York Times, Crisis of the Environment, Part II, Breaking the Biological Strand, Part IV, Preserve and Protect.
Wards Scientific-Land Pollution #3 of Environmental Pollution: Our World in Crisis, 70W3800.
LaMotte Soil Chemical Kits and Soil Book.
Soil Ecology, Andrews, Prentice-Hall Pub. Co.

Community:

Speakers: County Agriculture Agent
Agriculture Teacher
Earth Science Teacher

CONTINUED OR ADDED LEARNING ACTIVITIES

COGNITIVE: (Continued)

3. with key soil environmental factors.
4. Measure comparative soil temperatures and be able to report the differences to the class.
5. Determine the abundance and the complexity of invertebrate organisms in a soil ecosystem.
6. Determine by use of the Berlese funnel, that the arthropods are the most numerous of the soil inhabitants.

SKILLS USED: (Continued)

Comparison.
Data collection and recording.
Data interpretation.
Prediction.
Discovery.

CLASSROOM: (Continued)

2. b. Examine as many deep roadside and other open cuts as possible to observe the different kinds of materials.
   c. Follow this with a recent soil survey for the area. (These may be obtained from the Soil Conserv ation Service Office by asking your county agent.) The student could collect samples.
3. Compare air and soil temperature variations.
   a. The student will take the air temperature, then the soil temperature at the surface, 3 in. and 6 in. depths in the morning, noon and midafternoon on several different days. Obtain temperatures for the following: In the shade and in an open area; on a north and south slope; of soil of various textures; in a dry area, wet, and damp conditions; under different plant cover, with all other factors nearly alike.
   b. Discuss temperature range variations in air and soil and the effect of variations of temperature on organisms of soil.

(Continued)

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SUGGESTED RESOURCES

Publications: (Continued)

Pleistocene Geology of the Door Peninsula, Wis., Thwaites and Bertrand-Bulletin of the Geological Society of America, 1957.
Fundamentals of Ecology, Eugene Odum, Saunders Publishing Co.
Local soil surveys and soil testing pamphlets, U. S. Soil Conservation Service District Office.
National Wildlife Federation, EQ Index, 1970, Soil (pamphlet).

Audio–Visual:

Soilmakers: Decomposition by Simple Plants and Insects, 16 minutes, $6.00, U-W LaCrosse Film Library.

Community:

CONTINUED OR ADDED LEARNING ACTIVITIES

CLASSROOM: (Continued)

4. Analysis of invertebrate populations.
   The soil contains a great abundance of small and unfamiliar organisms, which present problems in identification. But this is not an insurmountable problem, for identification to order is all that is necessary.
   a. Select a sample plot, one meter square at random. Samples may be analyzed for pH, calcium content, and organic matter.
   b. The earthworm population of the quadrat may be sampled. Use a potassium permanganate solution to soak the quadrat; this will drive them to the surface where they may be collected, killed and fixed in alcohol.
   c. The number and species composition of the earthworm population for each quadrat should then be plotted on the map and correlated with pH, calcium, organic matter, vegetation and moisture. Draw conclusions on earthworm distribution as influenced by the soil environment.
   d. Information from a previous investigation on #3 soil temperatures may be used here. A plot map of distribution may be developed in relationship to soil temperature.
   e. Soil arthropods can be extracted from the soil by means of a Berlese funnel. See directions for operation of the Berlese funnel in BSCS Green Version High School Biology. (1st edition, the Student Lab Manual and the 2nd edition, the Text.)

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental: **Integrated with:**

CONCEPT NO. 2 - Ecosystem SUBJECT Biology

ORIENTATION Interaction Between Living Organisms and Environment TOPIC/UNIT Ecosystems

BEHAVIORAL OBJECTIVES

Cognitive:

Explain the relationship between plants and animals in a sealed ecosystem. Demonstrate a procedure for determining the relationship between plants and animals in an ecosystem.

Affective:

Suggest several simple ecosystems in the immediate area which demonstrate his understanding of organism interaction. Examples: marsh, woods, pond, etc.

Skills Used:
Scientific investigation.
Visual observations and recording these.
Effect thinking.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Set up 4 sealed containers with water in each. Label 1-4. Add aquatic plant to #1, add plant and aquatic animal to #2, add just animal to #3, and use #4 as control (just water). Using bromothymol blue, place an indicator in all 4 and observe condition of plants and animals and also indicator change. Place all 4 in light for 24 hours before making observation. Explain reasons for any changes.
2. Have students read about the structure of a community (BSCS Blue Version, Chapter 29). The above reading is an actual study of a lake community (Odell Lake) which explains the distribution and interrelationships among fish species. Also specie relationship to habitat is discussed in detail. Many questions are included in the text which can be used to stimulate class discussion.

Outside or Community:

1. Student can create his own miniature ecosystem. (Patterns and Processes, Rev. ed., p. 69).
2. Depending on availability, have students take a field trip to a natural area where they can directly relate to an ecosystem. Examples: marsh, woods, pond, etc.

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Books: High School Biology, BSCS Yellow Version - appropriate chapters. BSCS Green Version--Invest. 1-5 Interrelationship of Producers and Consumers. Ecology and Field Biology, Robert L. Smith, Harper & Row, 1966. Modern Biology, Otto, Towle, 1969 Ch. 49 and 50, Holt, Rinehart and Winston. Biological Science: Molecules to Man, BSCS, Blue Version, 2nd ed. **Audio-Visual:** (Continued) Filmstrip: Ecological Imbalance: Six Systems Dispoiled, FS St 2, Eye Gate House, Inc. Film: Distribution of Plants and Animals, BAVI. Polar Ecology: Predator-Prev. BAVI. Cry of the Marsh, Bill Snyder Films Box 2734, Fargo, North Dakota. Film Loop: BSCS, Mountain Trees - An Ecological Study. **Community:** (Continued) Guest Speakers: Representative from local DNR. Fish Biologist. Game Manager, etc.	PUBLICATIONS: (Continued) Biological Science: Patterns and Processes. Rev. Ed., BSCS Special Materials. AUDIO-VISUAL: (Continued) BSCS, Prey Detection in the Rattlesnake.

Environmental: **Integrated with:**

CONCEPT NO. 3 - Carrying Capacity **SUBJECT** Biology

ORIENTATION Population Diversity **TOPIC/UNIT** Populations, Societies, and Communities

BEHAVIORAL OBJECTIVES

Cognitive:

Determine the species distribution of plants by measuring the availability of sunlight with a light meter. Predict whether or not a given species of plant will grow well in an area if the amount of light available were to increase; decrease.

Affective:

Suggest that light could be the limiting factor influencing carrying capacity of plants in a given area. Challenge those that say that the amount of light available to plants does not determine the species that grow in a given area.

Skills Used:

Measurement.
Use of photometer.
Data collection.
Comparison.
Relationship of available light to photosynthesis.
Inferring.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Students might discuss primary production in regard to availability of light.
2. Make a comparison of data from at least two different environments; infer what effect light availability has on species composition and photosynthesis production.

Outside or Community:

1. With a light meter, the student will record readings from various places around school. If a wooded, shrub or brushy area is available, readings may be taken and then expressed as percentages of the values obtained in the open at the same time.
2. In a woods, for accuracy readings taken at 1 foot intervals along randomly, transects can be made. Sun flecks move with the changing position of the sun, and change in size, shape and intensity. Light intensity in other areas around the school at various levels, etc. may be recorded.
3. A discussion of F. Blackman's experiments on photosynthesis, light intensity and temperature should follow.

SUGGESTED RESOURCES

Publications:

Oosting, H. J., The Study of Plant Communities, W. H. Freeman and Co., 1956.
BSCS Blue Version, Chapter 9, Light as energy for life.
Dove, W. G., A simple chemical light meter. Ecology. 39:151-152.
Marquis, D.A. & G. Yelenosky. 1962. A chemical light meter for forest research. Northeast Forest Exp. Sta. Paper 165.
Platt, R. B. & J. E. Griffiths.
(Continued)

Audio-Visual:

Film:
Cave Community, BAVI.
Sea, BAVI.

Community:

Natural areas.

CONTINUED OR ADDED LEARNING ACTIVITIES

PUBLICATIONS: (Continued)

1964. Environmental measurement and interpretation. Reinhold, N.Y.
Ryther, J. H. 1956. The measurement of primary production. Limnol. Oceanography. 1:72-84.

GENERAL RATIONALE:

A record of certain physical factors of the environment is often essential in a critical study of a particular plant community. Some relatively simple methods may be used for gathering this data.

The most useful method available for the measurement of light intensity in the field is to use a photometer (a light meter) which records in foot candles.

Using high range with the light meter at right angles to the incident light, read the photometer. If you read less than 1000 foot candles, switch to low range. Certain photocells may be injured by prolonged exposure to intense light, do not expose to direct light. Photosynthesis, as other processes in plants and animals, proceeds at a rate dependent upon many environmental factors. Light being one of these, in combination with others can result in the greatest speed of such processes.

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 3 - Carrying Capacity

SUBJECT Biology

ORIENTATION Carrying Capacity

TOPIC/UNIT Populations, Societies, and Communities

BEHAVIORAL OBJECTIVES

Cognitive:

Predict in written form what can happen to a population if predators are removed.

Affective:

Demonstrate awareness of some of the environmental factors influencing carrying capacity of living organisms by identifying them in his community.

Skills Used:

Paragraph writing.
Applying ecological principles to different situations.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Read Carl C. Lamb's, The Last Winter. (See Suggested Resources on reverse side.) NOTE: This is available in most school libraries or a copy of the fable can be obtained from ICE Resource Center.
2. Class Discussion:
   a. What is a population?
   b. What is meant by habitat?
   c. Explain factors affecting population densities.
   d. Do and can populations reach equilibrium? Explain.
   e. Explain what is meant by carrying capacity.

Outside or Community:

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: The Last Winter, C. C. Lamb National Parks, March, 1970. Essay on Populations, T. R. Malthus, 1798 (Reprinted in Everyman's Library, 1914.) An Introduction to the Study of Animal Populations, H. G. Andrewartha, 1961, Univ. of Chicago Press, Chicago. Wildlife Investigational Techniques, H. S. Mosby, The Wildlife Society, Washington, D.C. **Audio–Visual:** Film Loop: BSCS --- Grouse-A Species Problem. **Community:**	

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Environmental:

Integrated with:

CONCEPT NO. 3 - Carrying Capacity

SUBJECT Biology

ORIENTATION Population Change

TOPIC/UNIT Populations, Societies, and Communities

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

BEHAVIORAL OBJECTIVES

Cognitive:

Compose a brief report discussing the types of competition observed and their effects in the study of limiting factors. Define the ecological problems caused by disruption of natural plant competition by man's activities.

Affective:

Suggest ways of eliminating or minimizing ecological problems caused by disruption of natural plant competition by man's activities. Conduct an experiment to determine various limiting factors involved in plant competition.

Skills Used:

Setting up an experiment.
Using control in experiment.
Observation.
Recording.
Presenting the data.
Devise experiments.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

Outside or Community:

1. Set up competition cultures in boxes or large pots. Include sets of plants of the same species planted at varying numbers per unit area. Identical plants may be planted in rows, then different plants in the next row or alternated, etc.
2. Determine density, average height of individuals, average fresh weights, average width of widest leaf on each plant. Other characteristics the students might choose as being important can be observed. Record results, submit report and discuss data.

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Chemical warfare among plants. Scientific American, 180:48-51, 1949, Bonner, James. BSCS-Green, Chapter 3, Communities and Ecosystems. **Audio-Visual:** Use sunflower, Helianthus annus, wheat, marigolds, mustard, tomatoes, etc. Film: Succession from Sand Dune to Forest, BAVI. **Community:**	GENERAL RATIONALE: The possession of suitable adaptations to the main environmental factors of a given community is no guarantee that a particular species will succeed in that community. The presence of other species introduces the factor of competition. In most cases, plants do not compete with each other in a direct physical fashion common to animal competition. Rather, they exert their effects on the environment, which then may cause changes on neighboring plants. For an obvious example, a tall plant will intercept light before it reaches a lower plant growing beneath it. Roots of one may grow more vigorously than those of another. Hence, delete the soil of water or nutrient salts. Such competition is well exemplified when individuals of the same species are grown at different densities. This might be an excellent opportunity to discuss Liebig's "Law" of the minimum; that is any limiting factor or minimum requirement can singly control or limit populations.

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Environmental:

Integrated with:

CONCEPT NO. 3 - Carrying Capacity

SUBJECT Biology

ORIENTATION Factors influencing carrying capacity.

TOPIC/UNIT Populations, Societies, and Communities

E. S. E. A. Title III - PROJECT I-C-E 59-70-0135-4

BEHAVIORAL OBJECTIVES

Cognitive:

Explain the effect of a given treatment, such as planting windbreaks, removing trees, etc. on the wind velocity at ground level.

Affective:

Study one environmental factor, the wind, which directly or indirectly influences the biotic community. Making daily observations of wind direction and velocity using the Buefort Scale. Suggest at least two environmental effects of wind upon producers within a local ecosystem.

Skills Used:

Observation.
Recording.
Presenting data.
Inferring from data.

STUDENT-CENTERED LEARNING ACTIVITIES

In-Class:

1. Implications of wind speed effects on plants and animals should be discussed.

NOTE:
Daily wind velocity can be obtained from local weather report on radio or TV. Also, a call to local radio station for weather statistics is helpful.

Outside or Community:

1. Students will make daily observations of wind and velocity, keeping and plotting of a daily record of these observations for a period of several weeks. The students will use the Buefort Scale.
2. Upon completion of data collecting, graphs prepared will be discussed.
3. If possible, it should be repeated during various seasons and a comparison made of direction and speed.

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SUGGESTED RESOURCES

Publications:

Earth Science. The world we live in. Namowitz, Stone. D. Van Nostrand Company, Inc. New York. Any earth science text or reference for background on wind origin, rotation effects, etc.

Audio–Visual:

Buefort Scale for gauging the speed of wind.
A simple wind vane might be constructed.
Newspaper or weather chart showing high-low pressure center, direction, etc.

Community:

CONTINUED OR ADDED LEARNING ACTIVITIES

GENERAL RATIONALE:

Various kinds of instruments are used to record data in community studies, some being fairly sophisticated and expensive. These instruments may be of four kinds: instantaneous, maximum-minimum, totalizing and recording.

A wind indicator may be fairly sophisticated and expensive. This exercise will be to measure one environmental factor, the wind, with relatively accurate, yet unsophisticated and inexpensive equipment.

BUEFORT SCALE - GAUGING THE SPEED OF WIND:

1. In a calm, smoke rises vertically.
2. In a light air, less than 3 miles an hour, smoke drifts, but weathervanes remain unaffected.
3. In a slight breeze, about 5 miles, wind is felt on the face, leaves rustle.
4. In a gentle breeze, about 10 miles, wind extends a light flag, small twigs and leaves are in motion.
5. A moderate breeze, roughly 15 miles, raises dust and loose leaves, moves small branches.
6. Fresh breeze, 20 miles, small trees sway, created waves on inland waters.
7. The strong breeze, 25-30 miles per hour, sets large branches in motion, umbrellas are troublesome, telegraph wires whistle.
8. In a high wind, about 35 miles per hour, whole trees are in motion, persons breast the blast with some difficulty.
9. Next the gale, 40-45 miles, when twigs are broken, human progress is impeded.
10. A strong gale, blows some 50 miles an hour, slight structural damage, chimneys, slats thrown down.
11. A whole gale, blows around 60 miles, seldom experienced inland, whole trees uprooted.
12. Still fiercer are the storm and the Hurricane as it is called on sea, Tornado or Kansas cyclone on dry land.

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 3 - Carrying Capacity

SUBJECT Biology

ORIENTATION Human Population Growth

TOPIC/UNIT Populations, Societies, and Communities

BEHAVIORAL OBJECTIVES	STUDENT–CENTERED LEARNING ACTIVITIES	
	In-Class:	Outside or Community:
Cognitive: Conduct a human population study in his own community by determining dependency load, population density, rate of change of population density, birth rate, death rate, and rate of natural increase.	(SEE ATTACHED SHEETS)	
Affective: Appreciate the method of determining population size giving him an awareness of how population statistics are obtained as a result of his participation in the study.		
Skills Used:		

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Biology: BSCS Green Version, T-R Malthus, Essay on Population, 1798. Paul & Anne Ehrlich, Population, Resource and Environment. BSCS: Investigating Your Environment, 1970. The Population Bomb, Paul Ehrlich. **Audio-Visual:** Film: Population - Ecology: BAVI. **Community:**	

Determining Population Size

Background Information

The size of the population of a given community, state or nation is basic information used by a variety of governmental and private agencies. Population data are not useful unless these data include the date the information was gathered, the method or procedure by which the data were gathered, and the exact geographical area in which the population is located. These basic data describe population size at one point in time. Additional data, obtained at other points in time, provide a descriptive record of changes in the absolute size of the population of a given area. Such basic data become useful in answering many questions related to space.

Procedures

a. Obtain the number of people now living in your community. Data can be obtained by (1) designing a procedure for securing information by a person survey, or (2) securing census data from your school or community library (Bureau of the Census, Department of Commerce), your Chamber of Commerce, local Planning Commission, or the nearest office of the Census Bureau.

b. Define or secure the geographic area in which the population is located.

c. If you use references, determine how and when the population data were secured.

Survey of Population By Age Groups

Background Information

Determining the age distribution of a population can provide information as to whether a population is declining, stable, or young. Such information is useful in predicting the future of populations in a given community.

Procedures

a. Obtain the ages (specific age, by five or by ten year intervals, etc.) on numbers of the residents in your community. Data can be obtained by (1) designing a procedure for asking a sample of residents; (2) securing census data from your school or community library (Bureau of the Census, Department of Commerce), your Chamber of Commerce, your local Planning Commission, or the nearest office of the Census Bureau.

b. Display these data in graph form and propose interpretations of your observations.

c. Compare the findings in your community with national and world-wide data.

Dependency Load Of A Population

Background Information

The dependency load of a population may be described as the proportion of individuals in a population who must be supported by the productive portion of the population. Technically, the assumption is made that the population under 15 years of age and over 65 years of age is not in the labor force and, therefore, depends on that portion of society that can be employed and considered part of the labor force.

You may wish to develop your own definition of the dependency load in your own community, based on a different set of assumptions. If you do, the procedures below will serve as an example of calculations to make, but you will need to modify the calculations to fit your own definition.

Procedures

a. Secure census data on the population in your community by age groups, say 0-4 years, 5-9 years, 10-14 years, etc.

b. Add up the population age groups to secure the TOTAL POPULATION at some particular time.

c. Add up the population groups age 65 and older.

d. Add up the population groups from birth to 14 years inclusive.

e. Add the over 65 years total (c) to the 14 years and under group (d) = TOTAL DEPENDENT POPULATION.

f. $\frac{\text{TOTAL DEPENDENT POPULATION}}{\text{TOTAL POPULATION}} \times 100 =$ PERCENT OF THE POPULATION THAT IS DEPENDENT

Measuring Population Density

Background Information

Population density is the number of individuals per unit of space. Measurement of population density is a useful way to compare the living space occupied by human populations. The unit of space (for example, square feet, acres, square miles, etc.), must be the same for the populations to be compared. Density measures provide data for discussing such topics as land use, crowding, changes in populations over time, etc.

Procedures

a. Select one or more suitable sample sites (a city block, a suburban area, etc.) of comparative size.

b. Determine the quantitative size (area) of the sample site (e.g. 1 square mile, 100 square meters, 1 acre, etc.).

c. Count the number of individuals (men, women, children, age groups or other data that you feel are significant to your problem).

d. Make computations as follows:

$$\text{Density per space unit} = \frac{\text{Number of individuals}}{\text{Area of sample site}}$$

A Question You Might Consider

What observable relationships are there between these densities and the quality or accessibility of the environmental factor under investigation?

Rate of Change of Population Density

Background Information

Population density investigations provide data on the number of people in a given amount of space at a particular time. This technique provides a standard way to determine how fast a population is changing in a particular locality. By calculating rate of change at different times for the same community, you can determine changes in rate. Can you think of other comparisons you can make with technique?

Procedures

Obtain data on density for the same population taken at two different time intervals (e.g. 1 hour, 10 days, 5 years) depending on your requirements. (See "Measuring Population Density")

Computations

Compute the rate of change using the following formula:

Step 1)

Long Form

$$\frac{\text{Time of First Sample } (T_1)}{\text{Time of Second Sample } (T_2)} = \text{Change of Time } (\Delta T)$$

Short Form

$$\frac{T_1}{T_2} = \Delta T$$

Step 2)

Long Form

$$\frac{\text{Population Density of First Sample}}{\text{Population Density of Second Sample}} = \text{Change of Population Density}$$

Short Form

$$\frac{D_1}{D_2} = \Delta D$$

Step 3) Long Form

$$\frac{\text{Change of Population Density}}{\text{Change of Time}} = \text{Rate of Change}$$

Short Form

$$\frac{\Delta D}{\Delta T} = R$$

Sample Problem

Step 1) $(T_1)1970 - (T_2)1910 = (\Delta T) = 60$ years

Step 2) $(D_1)3960$ people $- (D_2)1560$ people $= (\Delta D) = 2400$ people

Step 3) $\frac{(\Delta D)2400 \text{ people}}{(\Delta T)\ 60 \text{ years}} = (R) = 40$ people per year (rate of change)

Total formula may be used in the same way as follows:

$$\frac{D_1 - D_2}{T_1 - T_2} = \frac{\Delta D}{\Delta T} = R$$

Questions You Might Consider

a. What information is needed to make the interpretation of this change meaningful to your problem? To human population studies? Where and how could you obtain that information?

b. Plot your data - what does it indicate?

Determining Birth and Death Rates

Background Information

Data on birth rates and death rates make possible the determination of whether or not a population is growing, and the size of its growth. A basic unit of time, such as one year, must be selected and data on the size of the population at the beginning of each unit of time must be secured. Growth of some populations can be predicted from population growth data. Are there other factors you would need to include to calculate the future population growth in your community?

Procedures

a. Secure population data on your community from public records or from your own census.

b. Secure data on total deaths and total births for different years from public records in your community, for example, the Chamber of Commerce, the library, the Planning Commission.

c. Prepare a table with appropriate headings so that you can secure and record the data from public records that you will need for your calculations.

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Calculations

Calculate for any time interval (typically one year).

$$\text{birth rate} = \frac{\text{Total births}}{\text{Population Size}} \times 1000 = \text{birth/1,000/time interval}$$

$$\text{death rate} = \frac{\text{Total deaths}}{\text{Population Size}} \times 1000 = \text{deaths/1,000/time interval}$$

$$\frac{\text{birth rate}}{\text{death rate}} = \text{crude rate of natural increase per 1,000 population}$$

Determining Changes In Death Rates

Background Information

Periodic variations in death rates become of interest if variations are large and such variations can be correlated with environmental events.

Procedures

a. Secure death rate data for each month for at least 3 to 4 years for your community. These data can be obtained from your local public health agency or by contacting the nearest medical association.

b. Determine the population death rate for months.

c. Plot death rates for months, as shown below.

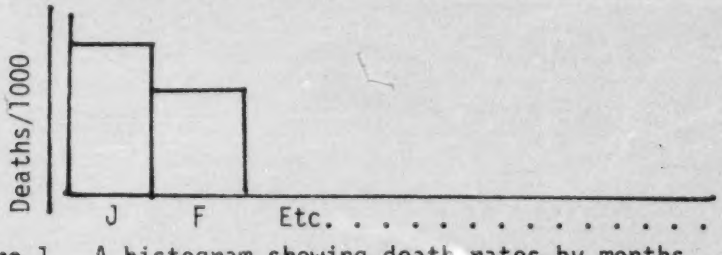

Figure 1. A histogram showing death rates by months.

A Question You May Wish To Consider

Can you account for regularity or irregularity of the patterns produced?

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental: **Integrated with:**

CONCEPT NO. 3 - Carrying Capacity **SUBJECT** Biology

ORIENTATION Population Growth **TOPIC/UNIT** Populations, Societies, and Communities

BEHAVIORAL OBJECTIVES

Cognitive:
Describe what happens in a natural population when checks and balances of a predator are removed, in a graphical format. Predict the effect on plants when the density of a given animal specie becomes greater; lesser.

Affective:
Appreciate the efforts of the DNR and realize the importance of game laws as they pertain to harvest of wildlife by citing examples. Promote the acceptance, by others, of the work carried out by the DNR in managing wild game and land.

Skills Used:
Analysis of and presentation of data.
Graph preparation.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Read worksheet on "Study of a Deer Population." Complete answers to the questions and discuss in class.
2. Do lab investigation, Population Growth: A Model, BSCS Green Version.
3. Do lab investigation, Study of a Yeast Population, BSCS Green Version.
4. Calculate the population density of trees, dogs, cats or some life form in your yard, block, town, or city.
5. Calculate the density of a particular plant in a limited area on the school grounds by actual count or by sample.

Outside or Community:

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SUGGESTED RESOURCES

Publications:

T. R. Malthus - Essay on Populations, 1798.
H. G. Andrewartha, 1961, An Introduction to the Study of Animal Populations, Univ. of Chicago.
Principles of Field Biology and Ecology, A. H. Benton & W. E. Werner.
Animal Ecology by S. C. Kendeigh.
Ecology by E. P. Odum.
Population Control in Animals by C. Wynne-Edwards.
Biology, BSCS, Green Version.

(Continued)

Audio-Visual:

Special on Wolf Population in Michigan.

Wildlife Investigation Techniques, H. S. Mosby. The Wildlife Society, Washington, D.C.
Film: Ecology of Plateaus, 8 minutes, Examines Kaibab Plateau and its natural balance. UW-LaCrosse, $3.50.

Community:

DNR Representative.
Local area or plot studied.

CONTINUED OR ADDED LEARNING ACTIVITIES

PUBLICATIONS: (Continued)

Modern Biology by J. H. Otto and Albert Towle, Holt, Rinehart & Winston, Chapter 49.
Inquiry into Biological Science, Jacobson, Kleinman, Hiack, Carr and Sugarbaker, American Book Van Nostrand Co., 1969.

WORKSHEET: STUDY OF A DEER POPULATION

A predator control program was started at the Kaibab National Forest on the rim of the Grand Canyon in Arizona in 1907. Cougars, wolves, and coyotes were hunted and killed by the most efficient methods possible. These predators had been attacking sheep and cattle on neighboring lands as well as the deer of the National Forest.

By 1910, the deer herd, which had long remained balanced at about 4000 animals, started to increase rapidly. By the year 1918, observers knew there was a deer population explosion, because the herd had increased to an estimated 30,000 animals. The predator control program was a success.

Biologists of the U. S. Forest Service were proud and happy. But there were doubters. Arguments and meetings were held while the predator control program continued, and the deer herd grew. By 1923, 674 cougars, 11 wolves and 3000 coyotes had been killed in the Kaibab National Forest. By 1923, seven independent investigators had warned the U. S. Forest Service of impending disaster. The deer herd continued to grow. By midsummer, 1924, the herd was estimated at 100,000 animals. The rise from 4000 to 100,000 deer in 17 years was clearly a triumph in game management.

The winter of 1924 came early and hard to the Kaibab National Forest. Snows were heavy and temperatures low. The winter of 1925 was the same. During the long, snowy, cold winter of 1924 and 1925, 60,000 deer starved to death.

1. Sketch a graph of the deer population between 1910 and 1925.
2. What determiners of population density were responsible for the change in the deer population?
3. In what way did environmental factors influence the determiners of population density?
4. What do you think would happen to the deer population if the predator control program was continued beyond 1925? What if the predator control program was halted?

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 3 - Carrying Capacity

SUBJECT Biology

ORIENTATION Limiting Factors on Population Growth

TOPIC/UNIT Populations, Societies, and Communities

BEHAVIORAL OBJECTIVES	STUDENT–CENTERED LEARNING ACTIVITIES	
	In-Class:	Outside or Community:
Cognitive: Determine population growth of fruit flies in a closed environment using the direct count method. Compare and contrast the factors responsible for regulating the fruit fly population with their effect on the regulation of the human population.	1. Prepare several vials of fruit fly media. Directions for media preparation can be found in most any laboratory guide for biological sciences. Introduce three pair of flies into each vial. Have student count the number of flies daily for the next 3-4 weeks. (For method of etherizing fruit flies to make counts, observe BSCS Blue Version 2nd ed., p. 311.) Students should graph results plotting time against number of fruit flies. Teacher discussion should follow. The discussion should focus on factors effecting population size. Examples are: available food, space, toxic waste, crowding, etc.	
Affective: Seek examples of limiting factors influencing population growth in his community. Accept the fact that the population has the effect of regulating itself, if no outside factors are introduced.		
Skills Used:		

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Biological Science: Molecules to Man, BSCS, Blue Version, 2nd ed. Carolina Drosophila Manual - from Carolina Biological Supply Company. **Audio–Visual** Film: Population Ecology, BAVI. **Community:**	

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 4 - Water

SUBJECT Biology

ORIENTATION Water Resources

TOPIC/UNIT Water Cycle

BEHAVIORAL OBJECTIVES

Cognitive:

Determine all phases of the movement of water in our atmosphere, on the earth's surface and underground. Construct a model that will illustrate several ways in which water runoff can be reduced.

Affective:

Defend the restrictive controls of water during the year in his community and realize man's part in water usage and control. Accept the fact that water usage must be curtailed during certain times of the year, by not trying to cheat, i.e. watering the lawn during a ban, etc.

Skills Used:

Make drawing to show water cycle.
Develop ability to collect data.
Construct scientific instru.
Interpret information.
Make comparisons.
Visual observations.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Build simplified rain gauge - graduated empty pop can.
2. Search for information on water table depths and how they vary during the year. Use local well driller or water department official to supply information.
3. Discuss what an aquifer is and its influence on man and vice versa.

Outside or Community:

1. Determine precipitation amount at school site, or home by rain gauge and compare with nearest weather station data.
2. Observe effects of runoff on various soils and covers. (grass, forest, plowed field, compacted pasture, slopes, lawn, snowmobile path)
3. Build simple demonstration showing water runoff with and without various covers. Use grass, leaves, gravel, bare soil.
4. Determine through water department records, the difference of demands for water during summer months and winter months and then discuss effect on water table. Try to list ways man increases his use of water during summer months.

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Biology, Addison Lee, The Steck Co., 1964, p. 249. High School Biology, BSCS, Yellow Version. **Audio–Visual:** Film: The Stream, ACI Films, Inc. New York, 1971. Understanding Lakes and Lake Problems, I-C-E RMC, Kit 53. **Community:** Water Dept. representative. DNR authority. Weather station. Well drilling company.	

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E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 4 - Water

SUBJECT Biology

ORIENTATION Human Water Consumption

TOPIC/UNIT Water Cycle

BEHAVIORAL OBJECTIVES

Cognitive:

Determine the average yearly water usage in the U.S. Compare the average yearly water usage in the U.S. with the water provided by the yearly rainfall. Predict the consequences to both plants and animals in the U.S. if the yearly rainfall were to be reduced to one-half of its present amount.

Affective:

Promotes proper water usage procedures for the school and community by listing several guidelines in this area.

Skills Used:

Individual investigation of daily water usage.
Compile data.
Make comparisons of data.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Make an approximation of water usage in the U.S., first calculate individual usage and guess amount in gallons. Assume U.S. population at 200 million and find U.S. usage. Compare class results and discuss differences. Find average.
2. Assume rainfall is source of all water we use. Use 20 in. as average rainfall for U.S. Estimate how many gallons of water in a sq. ft. covered to a depth of 30 in., over a sq. mile. Assume square miles in U.S. to be 3,600,000. How much water falls in U.S. in one year? How does this annual amount of rainfall compare with first amount of water used? Discuss comparisons and bring in idea of water cycle and industrial usage of H_2O.
3. Make a diagram of water cycle.
4. In conjunction with math classes, set up oroblems, figures and calculations of projected water usage for a bubbler in school, for a school shower, while you brush your teeth.

(Continued)

Outside or Community:

1. Determine your family's water consumption. Divide by number of individuals. How does this compare with others, class average, community, state, or national?
   a. Make or use water collection instruments, rain gauge, or/and get figures from the nearest local weather station.
2. Visit water treatment facilities.
3. Resource person from water department to talk to groups.

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Any geography book for national rainfall average. **Audio–Visual:** Film: Rise and Fall of Great Lakes, Canadian Films. Who Killed Lake Erie? BAVI, Env. Supplement. **Community:** Math teacher. County weather station for annual rainfall.	CLASSROOM: (Continued) 5. Make graphs to illustrate water usage, rainfall, etc. 6. Compare well versus lake, etc. for water source, pre-treatment costs, etc. 7. List how you as an individual use and alter water quality.

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 4 - Water

SUBJECT Biology

ORIENTATION Quality of Water

TOPIC/UNIT Water Resources

BEHAVIORAL OBJECTIVES

Cognitive:

Test water determining concentrations of many substances which are indicators of water pollution. Observe the physical characteristics of a body of water and predict whether or not it is polluted.

Affective:

Appreciate the procedure used in testing water quality and the origin of data as we read about it in local newspapers and journals by stating "It's important that it be done even though its time consuming," or something to that effect. Challenge a statement such as, "The water is polluted," "not polluted," unless it is based on accepted test results.

Skills Used:

Use of water testing kits.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

(SEE ATTACHED SHEETS)

Outside or Community:

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: BSCS: Investigating Your Environment, 1970. Environmental Pollution, Prentice-Hall. Freshwater Ecology, Prentice-Hall. **Audio–Visual:** Film: Millipore Technique, Free, Millipore Corp. Bedford, Mass., 01730. LaMotte or Hach water test kit. **Community:** Representatives: Water treatment plant to discuss chemical additives. Sewage plant to discuss sewage treatment. Local industry, paper, foundry, etc. to talk on their industrial use of water. Local water samples.	

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Determining Water Temperature

Background Information

Water temperature is usually close to the temperature of the atmosphere. Water is a vast storehouse for heat energy derived from the sun and the atmosphere. A pond, small though it is, warms or cools very slowly in accordance with the seasons, a matter of great importance to aquatic life which cannot cope with sudden, drastic changes. Larger bodies of water may be almost totally unaffected by sudden changes in air temperature except close to the surface.

When there is considerable turbulence in moving water, the temperature will not vary much as the depth increases. Turbulence prevents layering and one reading is usually sufficient.

Materials and Equipment

a. One centigrade, maximum-minimum thermometer

b. One common chemical thermometer (+ or - .2C)

c. Rope or cord calibrated in 6 inch increments.

Procedures

The common chemical thermometer is adequate for measuring surface temperatures in still or moving water.

The maximum-minimum thermometer is the least expensive device for measuring sub-surface temperatures. The scale on the left side of the thermometer measures low temperatures. The scale on the right side the highest temperature. A tiny wire index in each column registers the lowest and highest temperature encountered.

To operate the thermometer, use a magnet to move each index down to the top of the mercury column. Lower the thermometer on the calibrated rope to the desired level and allow a five minute interval for an accurate reading. Bring the thermometer to the surface and read the temperature from the lower end of the index on the cold side. When the air temperature is colder than the surface water it will be necessary to set and read the warm side of the instrument until temperatures are reached that are as cold or colder than the air.

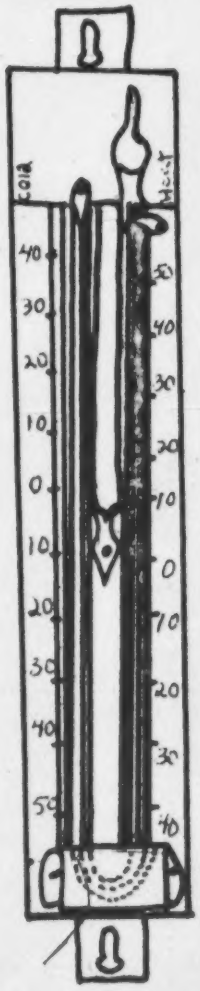

Figure 1. A Maximum-Minimum Recording Thermometer

The maximum-minimum thermometer has certain limitations: it is fragile and easily broken; it cannot be used at great depths without danger of crushing; between each reading one has to bring the instrument to the surface; and the reliability of the indices should be checked frequently. The exact procedures for measuring temperatures will vary with the body of water. However, to obtain the most reliable data, consider the following ideas; recordings during several times of the day may yield different data, water temperatures may vary with depth in still water but is usually consistent in moving turbulent water, and when water sources converge (other streams, ditches or pipes) this convergence can cause changes in temperature.

Determining The Amount Of Suspended Materials Carried By Running Water

Background Information

One measure of the quality of running water can be how clear it is. Water clarity can be affected by soil runoff, industrial wastes, city sewage, and the growth of microorganisms. The following test can give you comparisons of the materials carried by water.

Materials and Equipment

a. Quart mayonnaise jars or other convenient bottles

b. Graduated cylinders

Procedures

Collect samples of water from various streams in jars or other containers and bring it to the laboratory. Stir and mix your samples until there is no visible material on the bottom. Pour into the graduated cylinder up to the top graduation. Allow the water to stand for twenty-four hours. Compute the percentage of the volume that appears to have been in suspension. To determine the nature of the suspended materials, see the technique on "Microscopic Examination of Materials in Water."

The Secchi Disc Method For Determining Limits of Visibility In Water

Background Information

The Secchi disc can be used to obtain a rough index of the visibility of objects in water. Indirectly this is an estimate of the depth to which light will penetrate in a particular body of water. Light penetration in water is most often prevented by either concentrations of living things or the presence of non-living materials such as sand or silt.

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The Secchi disc has come into common use as a way of comparing one body of water with another or comparisons of the same body of water at different times. Since the amount of light reaching the subsurface waters determines the depth to which photosynthesis can occur, Secchi disc readings do provide information about the potential productivity of a body of water.

Materials and Equipment

a. Disc, 20 cm diameter, heavy plastic or wood

b. Eye bolt and weight

c. Heavy string, knotted at every 1 foot interval

Procedures

The disc itself can be made in almost any workshop or purchased from science supply houses. The best material is probably acrilic plastic or a similar material that will not become waterlogged with use. Wood or sheet metal may also be used.

The disc is 20 cm in diameter, and should be painted, as illustrated in (A) below. The black and white paints that are used must be pure and striking in order to get dependable results.

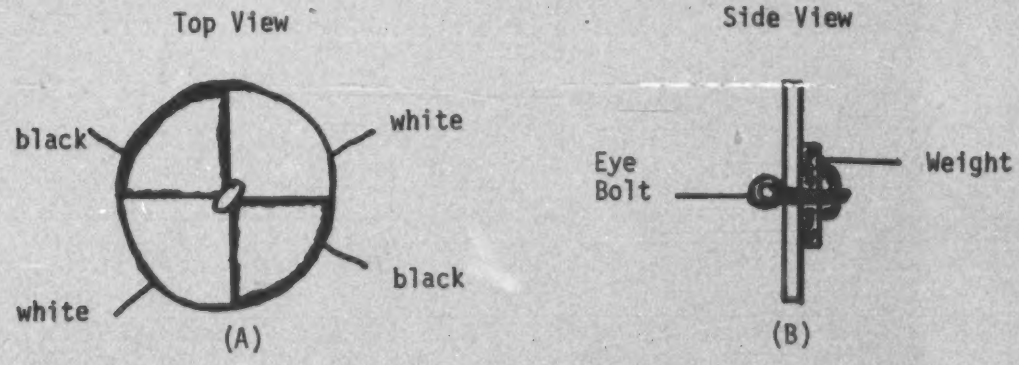

Figure 1. A Secchi Disc

Standard conditions for the use of the Secchi disc are: overhead sun, no clouds, shaded and protected side of boat or dock, and minimal waves or ripples. If you take readings under other conditions, these should be recorded.

The test is best done from a boat, dock, or any similar place close enough to the water so that the disc can be lowered into the water. The distance at which the disc disappears from view is noted. Then lift the disc and note the distance at which it reappears. The average of the two readings is the limit of visibility.

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Determining The Amount Of Oxygen Dissolved In Water

Background Information

The solvent power of water allows molecules of other substances to spread through the water, and in doing so, make available oxygen gas to aquatic organisms. Under ordinary conditions, water contains 30 times less oxygen for a given volume than is present in air. Terrestrial animals have no difficulty in acquiring sufficient quantities of this essential gas, but a fish, for example, must not only be very efficient at removing oxygen from the water, but is in jeopardy whenever the quantities of dissolved oxygen diminish during normal seasonal changes (high temperatures or an impervious ice cover) or when it is consumed in large quantities by other organisms, such as bacteria. The animals that are present in a body of water are restricted to oxygenated regions.

Materials and Equipment

LaMotte dissolved oxygen kit containing:

Manganese sulfate solution	Titration flask
Alkaline Potassium Iodide Solution	Micro Burette
Sulfuric Acid	Sodium Thiosulfate solution
0.5 ml dropping pipette	

Procedures

a. Rinse the sample bottle in the water to be tested. Collect a sample of water from the desired depth. Make certain that it contains no air bubbles. Record the temperature of the water at the same depth. When taking a sample in shallow water, cover the mouth of the bottle tightly with the cap and submerge the bottle to the desired depth. Remove the cap to allow water to enter the bottle. Squeeze the bottle or tap the sides to dislodge any air bubbles clinging to the inside of the bottle. Replace the cap while the bottle is still under water. After bringing the bottle to the surface, examine it to be certain that no air bubbles are present in the sample.

b. To the sample add 8 drops of Manganese Sulfate Solution and 8 drops of Alkaline Potassium Iodide Solution. Carefully cap the bottle, mix by gently inverting, then allow the precipitate to settle below the shoulder of the bottle. CAUTION: No air should be introduced with the reagents. Reagents are added by allowing the drops to fall onto the test sample. Because of the greater density of the reagents, they will quickly descend into the sample. After each addition of reagent, the bottle is carefully capped for mixing, making sure that no air bubbles are formed.

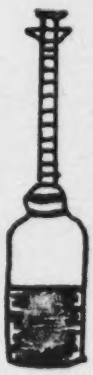
c. Add one measure (0.5 ml) of sulfuric acid (handle with care), cap the bottle and mix until the precipitate is completely dissolved. When you have added the acid, contact of the water sample with air will not affect the final reading. Samples collected in the field can be "fixed" by carrying out steps (b) and (c) on location and the final steps can be completed at a later time.

d. Next pour your water sample into the titration flask up to the 50 ml line.

Then fill the Micro Burette with standard sodium thiosulfate solution by

(1)

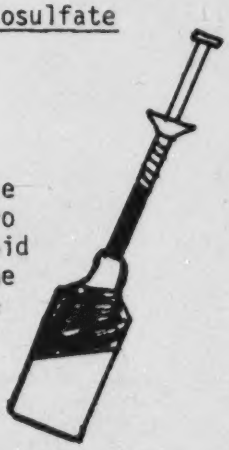
inserting the Micro Burette into the plastic cap of the reagent bottle



then

(2)

invert the reagent bottle and fill Micro Burette. Avoid bubbles in the Micro Burette

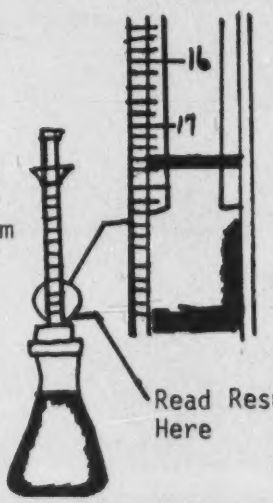


Now (3)

Place tip of Burette into plastic cap of Titration Flask

(4)

Add reagent until color changes from brown



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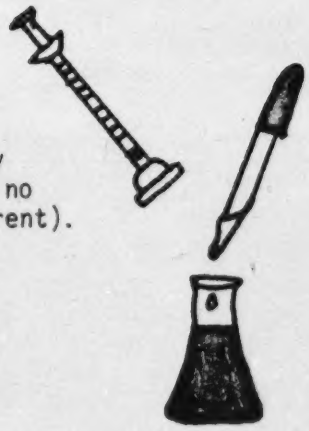
(5)

Remove Micro Burette and add 8 drops of starch solution (starch may be added earlier if no brown color is apparent).



(6)

Continue adding reagent while gently swirling flask, until blue color just disappears. If it is necessary to refill, record total amount of reagent used.

e. Converting the amount of reagent used to the number of parts per million of oxygen there were in your sample is an easy task. Each major division on the LaMotte Micro Burette is equivalent to 0.2 ppm dissolved oxygen and each minor division 0.004 ppm.

Calculations

If it required 18 major and 1 minor divisions to reach the titration endpoint the reading would be (18 x 0.2) plus 2 x 0.04 or 3.6 ppm dissolved oxygen.

The Table below will give you a way of comparing your results with the amount of oxygen that could be dissolved in the water.

Table 1

Amount of Dissolved Oxygen in Water at Different Temperatures When Exposed to an Atmosphere Containing 20.9 Per Cent of Oxygen under a Pressure of 760 mm. Including Pressure of Water Vapor*

Temp. °C.	Parts per Million	Cc. per liter (at 0°C. and 760 mm.)	Temp. °C.	Parts per Million	Cc. per liter (at 0°C. and 760mm.)
0	14.62	10.23	16	9.95	6.96
1	14.23	9.96	17	9.74	6.82
2	13.84	9.68	18	9.54	6.68
3	13.48	9.43	19	9.35	6.54
4	13.13	9.19	20	9.17	6.42
5	12.80	8.96	21	8.99	6.29
6	12.48	8.73	22	8.83	6.18
7	12.17	8.52	23	8.68	6.07
8	11.87	8.31	24	8.53	5.97
9	11.59	8.11	25	8.38	5.86
10	11.33	7.93	26	8.22	5.75
11	11.08	7.75	27	8.07	5.65
12	10.83	7.58	28	7.92	5.54
13	10.60	7.42	29	7.77	5.44
14	10.37	7.26	30	7.63	5.34
15	10.15	7.10			

Determination of CO_2 In Water

Background Information

Carbon dioxide, unlike oxygen, dissolves readily in water. You would expect to find about as much carbon dioxide in a given volume of water as there would be in a like volume of air.

Carbon dioxide enters natural waters through the surface of the water and also through the respiration of plants and animals. It is an essential raw material for photosynthesis in aquatic plants. Abnormally high concentrations of carbon dioxide have a detrimental effect on most living things.

*Taken from W. H. Bruvold. "Scales for Rating the Taste of Water." Journal of Applied Psychology 52:245-253, 1968.

Materials and Equipment

LaMotte Kit PCO containing:
- Titration tube (code 0299)
- Phenophthalein Reagent (code 2246)
- Carbon dioxide Reagent B (code 4253)
- Micro Burette

Procedures

a. Follow the Micro Burette instructions in the technique, "Determining the Amount of Oxygen Dissolved in Water."

b. For reliable results, the test should be made on a freshly obtained sample, preferably a sample obtained with a minimum of contact with the air (avoid splashing).

c. The titration tube is filled to the mark with the water to be tested.

d. Add 2 drops of Phenolphthalein. If the sample turns red, no free carbon dioxide is present.

e. If the solution is colorless, add carbon dioxide reagent B drop by drop from the Micro Burette until a faint, but permanent pink color is produced and persists for at least 30 seconds. Gently agitate the sample during the titration.

f. Note the Burette reading. Each major division on the Burette equals 2.5 ppm carbon dioxide and each minor division, 0.5 ppm.

EXAMPLE: If the Burette reading is 10 major divisions the result of the test is (10 x 2.5 ppm = 25 ppm) plus (2 x 0.5 ppm = 1 ppm) or 26 ppm free carbon dioxide.

Rating The Taste Of Water*

Background Information

The taste of water coming from domestic water systems is influenced by the kinds and amounts of substances dissolved in it. Recently, reliable scales have been developed which, when properly used, can be used to assess consumer attitudes on the quality of the water in their water system. In laboratory and field studies consumer responses were significantly correlated with the total amounts of dissolved material in their water supply.

*Taken from W. H. Bruvold. "Scales for Rating the Taste of Water." Journal of Applied Psychology 52:245-253, 1968.

Procedures

NOTE: Although general suggestions are made here, see the appropriate techniques under "Survey Methods" for conducting a survey on water tastes.

You can choose any one of the four scales provided. Each seems to perform the task equally well. Using more than one or mixing them may take an unnecessary amount of time or yield unreliable results.

In securing consumer attitudes about the local water supply be certain that the water tasted comes from the tap and that the rating is done right after the respondent has had at least two or three swallows of water.

Four Taste Scales

Hedonic Scale

1. I like this water extremely.
2. I like this water very much.
3. I like this water moderately.
4. I like this water slightly.
5. I neither like nor dislike this water.
6. I dislike this water slightly.
7. I dislike this water moderately.
8. I dislike this water very much.
9. I dislike this water extremely.

Quality Scale

1. This water has an excellent taste.
2. This water has a very good taste.
3. This water has a good taste.
4. This water has a slightly good taste.
5. This water has a neutral taste.
6. This water has a slightly bad taste.
7. This water has a bad taste.
8. This water has a very bad taste.
9. This water has a horrible taste.

Action Tendency Scale

1. I would be very happy to accept this water as my everyday drinking water.
2. I would be happy to accept this water as my everyday drinking water.
3. I am sure that I could accept this water as my everyday drinking water.
4. I could accept this water as my everyday drinking water.
5. Maybe I could accept this water as my everyday drinking water.

6. I don't think I could accept this water as my everyday drinking water.
7. I could not accept this water as my everyday drinking water.
8. I could never drink this water.
9. I can't stand this water in my mouth and I could never drink it.

Combination Scale

1. This water tastes real good. I would be very happy to have it for my everyday drinking water.
2. This water tastes good. I would be happy to have it for my everyday drinking water.
3. This water has no special taste at all. I would be happy to have it for my everyday drinking water.
4. This water seems to have a little taste. I would be satisfied to have it for my everyday drinking water.
5. This water has a mild bad taste. I could accept it as my everyday drinking water.
6. This water has a fairly bad taste. I think I could accept it as my everyday drinking water.
7. This water has a bad taste. I don't think I could accept it as my everyday drinking water.
8. This water has a real bad taste. I don't think I would ever drink it.
9. This water has a terrible taste. I would never drink it.

Methods of Analyzing Various Odors From Water

Background Information

Odors in water are frequently caused by decaying organic matter or sewage. Chemical wastes from industrial plants can also produce smells. Some microscopic organisms also yield odors as byproducts of their metabolism. Odors are a significant index of the quality of water supply because you are able to detect substances in water at levels as low as a few micrograms/liter.

Have several members of your team smell the sample, study the descriptions and pick the term most appropriate before they compare answers.

Materials and Equipment

Standard Collection Bottles and Thermometer

Procedures

Odor tests should be conducted when the samples are being obtained because many odors are due to dissolved gases which quickly leave the containers.

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To obtain a qualitative description of the odor of the sample, remove the glass stopper from a standard collecting bottle after first shaking the sample. Sniff the odor lightly. Record the description which best describes the odor noted. For most reliable results, the samples should be tested at a temperature of approximately 40°C.

Odor: Qualitative Descriptions

Spicy odor
Vanilla or Balsam
Sweetish
Industrial or chemical smell
Petroleum odor
Rotten eggs - H_2S
Fishy odor
Sewage odor
Peaty odor
Rotting straw
Rootvegetable odor
Cucumber-like odor
Geranium-like odor
Violet-like odor
Chlorine
Medicinal odor
Disagreeable
Pin pen smell
Damp earth
Crushed grass odor
Moldy-damp cellar

Water Quality: Estimating Differences in Biological Diversity*

Background Information

Streams, ponds and lakes that have been unaffected by human activity and have established a dynamic equilibrium over a period of time are characterized by large numbers of kinds of aquatic organisms. These plants and animals are adapted to particular niches in the aquatic ecosystem. The numbers of each type generally remain rather stable over the years, although there will be seasonal variations in numbers.

In general, if new substances foreign to the organism enter the water, each species will be influenced in a particular way. When materials poisonous to life enter the ecosystem in small quantities, some species may be completely destroyed. With this destruction, more tolerant species will be able to increase their numbers as competition is reduced. A study of the number of kinds or types of organisms and the numbers of individuals of each type, may, therefore, be studied to determine changes that are occurring or have occurred in the ecosystem. The graph below gives an expression of these relationships.

(Graph on reverse side)

*Adapted from Cairns, et. al. "The Sequential Comparison Index." A Simplified Method for Non-Biologists to Estimate Relative Differences in Biological Diversity in Stream Pollution Studies. Journal of Water Pollution Control Federation, September 1968.

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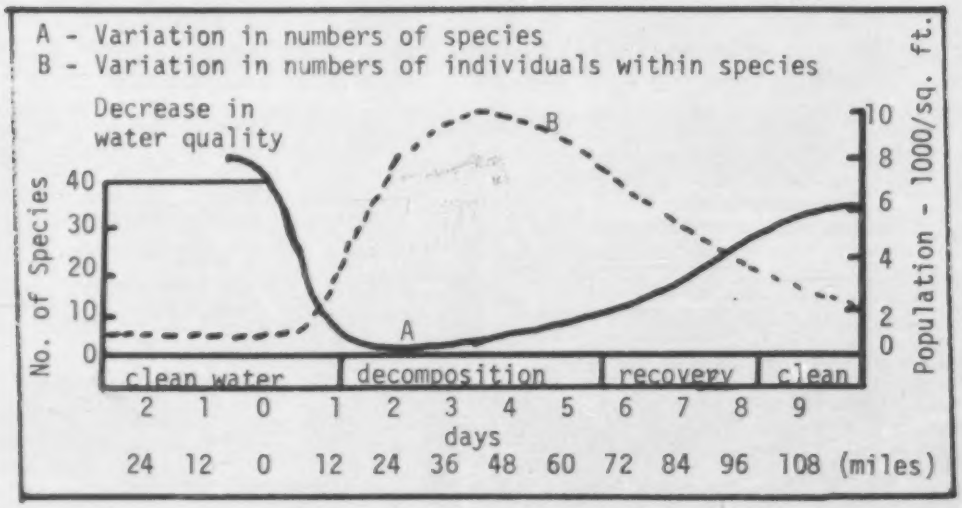

Figure 1. Relationships of the number of species to the numbers of individuals within species in a stream.

Collecting Procedures

It is possible to estimate the effects of changes in water quality on aquatic habitats by sampling and comparing the organisms at different points in the system. Consider the following sampling procedures to see if they fit your needs. If not, invent your own.

Passive Sampling

These methods involve placing some structures or objects at several places in the stream for a fixed amount of time, then removing the objects, recording the organisms that have become attached and comparing the numbers of species.

Sampling with Synthetic Sponges

Anchor small pieces of sponges (1" x 3" x 4") near the bottom of the stream for approximately 14 days. Remove the sponges from the water and squeeze the fluid into a jar of preservative so the organisms can be counted later (a 5% solution of formalin will do). This technique will usually collect only small plant-like forms.

Multiplate Sampler

This sampler can be constructed of wood or other materials to which organisms will adhere. It is made of alternating layers of large (6 to 10 inch squares of wood or hard board with small (1 to 2 inch) squares that are held together by a threaded bolt. (See Figure 2.)

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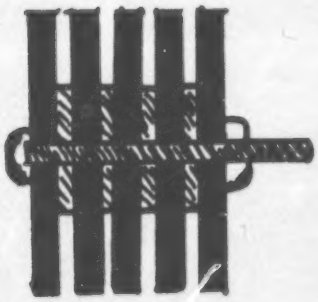

Figure 2. A Multi-plate stream sampler

This sampler should remain in the water for at least 14 days. When it is removed the sampler should be taken apart and all attached organisms placed in 5% formalin.

Less complex samplers can be made from pieces of wood or rock placed in the desired places in the stream.

Active Sampling

This implies that you will go to the selected sites and gather the organisms immediately. The technique used will be determined by the kind of organisms present, the nature of the bottom of the water, and partially whether it is feasible or safe to personally enter the water. In general, the following techniques and equipment should be considered:

a. Seines and nets for collecting large organisms which try to avoid capture such as fish or crayfish.

b. For slow moving or attached bottom organisms, consider scraping rocks or other submerged objects directly into preservatives. To make comparisons between one area and another, construct a sampling frame 1 to 2 feet square from metal or wire, lay this frame on the bottom and collect within that area. This will allow you to sample the same area at each site.

Counting

In counting organisms, it is not necessary that you identify each one. You only have to compare an organism with the one you just looked at and note whether it is similar or not. Let's look at how a typical count of microscopic organism might proceed.

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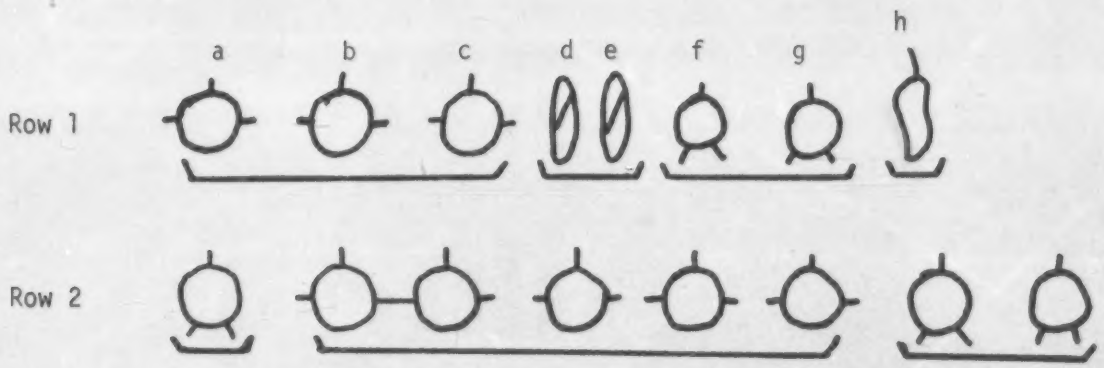

Figure 3. Counting Diversity of Organisms

Suppose when you look through your microscope you see the organisms in Row 1. Beginning with organism (a) through organism (c) they all appear to be the same. For this category system we would say they are all in the same "run." The next run would start with organism (d) and include all organisms until an unlike organism is located, that would be up to organism (f). So the second run would include (d) and (e). The next run is composed of organisms (f) and (g) and the last run only one, organism (h). So Row 1 has 8 organisms and 4 runs. Row 2, with fewer kinds of organisms, has 8 organisms and 3 runs.

You use the same system for classifying organisms regardless of the size although there are some slight differences in the way you proceed. For counting microscopic forms place 2 drops of a sample on a slide and cover with a cover slip. Start at the upper left corner of the cover slip and count across being careful not to count the same organisms twice. Count until several hundred organisms have been recorded. An easy way to record your count is to designate your first organism (x). If the next one is like the first another (x); if not an (o). A typical tally might look like this: x x x o x o o o x x o o. The number of runs is then the number of alternate groups of (x's) and (o's).

For larger organisms the jars are emptied onto trays and counted in the way in which they fall. If they are clumped, then pour on liquid until the clumps break up. The counting proceeds the same.

To establish which areas have the greatest diversity compute the Diversity Index according to the following formula:

$$\text{Diversity Index (DI)} = \frac{\text{Number of Runs}}{\text{Number of Specimans}}$$

The larger the D.I., the greater the diversity in the habitat.

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Quantitative Microscopic Examination of Materials In Water

Background Information

Water may be clear or cloudy, green or brown, free of odors or foul smelling. All of these qualities are affected by the kinds of living and non-living materials in the water itself. Sometimes even clear looking water may contain organisms or substances that make it unusable for special purposes. If your problem involves locating and describing causes of inferior water quality, and you have eliminated additions of chemical substances, consider using this technique.

Materials and Equipment

a. Sterifil[tm] Aseptic Filter System from Millipore Corporation (CAT. # XXII04700)

NOTE: This system contains more parts than ycu will need. Only those essential parts will be described and named.

Figure 1. Sterifil[tm] Aseptic Filter System

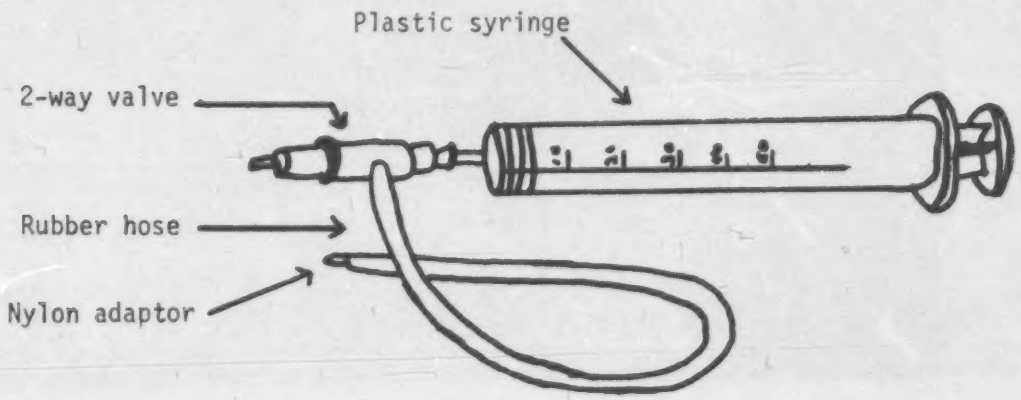

Figure 2. Millipore Vacuum-Pressure Pump, Catalog #XKEM00107

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b. Microscope
c. Forceps
d. Microscope slides 2" x 3"
e. Immersion oil (general oil may be substituted)
f. Drying oven (optional)

Procedures

Assemble the filter system

a. Tighten the filter holder over the receiver flask and set a filter on the filter holder.

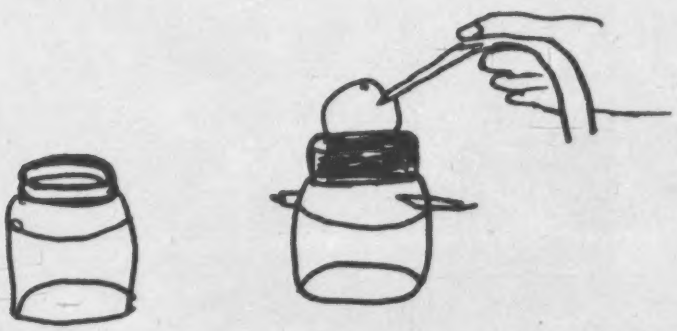

Figure 3. Placing the filter on the filter holder.

b. Attach the funnel to the filter holder. Connect the rubber base of vacuum pressure pump to one hose part and cover the other with a rubber cap.

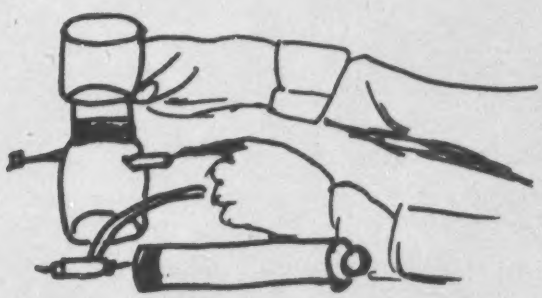

Figure 4. Attaching the vacuum pressure pump.

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Pour a known volume of your water sample into the funnel. (Using an even number of sls such as 10 or 100 simplifies future computations) If sample is thick with materials, use a smaller amount than if the sample seems clear.

To pump the sample through the filter, hold the syringe firmly with the left hand, and work the plunger rapidly back and forth with the right hand, over about half the length of the barrel. This will draw air out of the flask, and normal atmospheric pressure acting on the surface of the liquid in the funnel will start to push it through the filter.

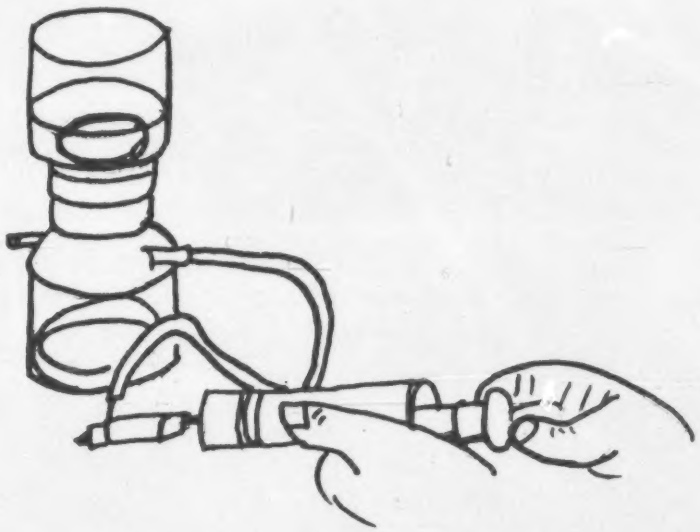
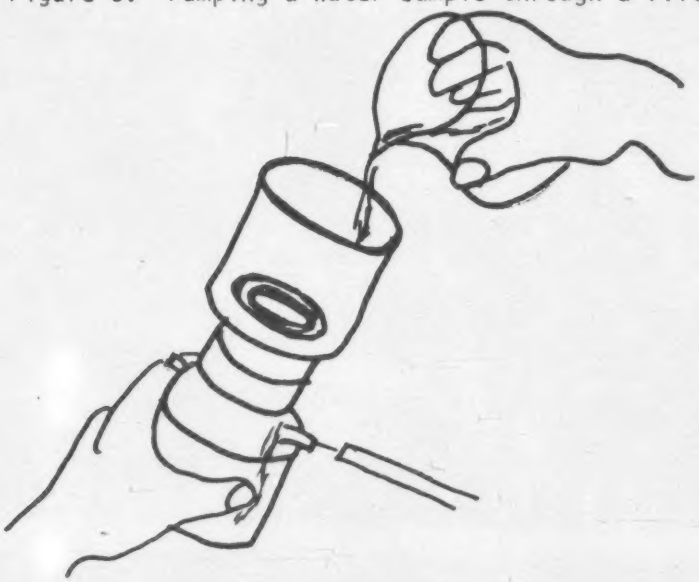


Figure 5. Pumping a water sample through a filter.



To insure that all organisms in the sample reach the filter gently wash down the walls of the flask with distilled water.

Figure 6. Washing the funnel.

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Unscrew the funnel from the filter holder. Carefully remove the filter and place it on a few drops of immersion oil on a clean 2" x 3" microscope slide. Add a few drops of oil to the top of the filter. The filer will become transparent when the oil replaces the water in the filter pores. NOTE: Warming the slide in a low temperature oven reduces the clearing time to 10-15 minutes.

Figure 7. Removing the filter and preparing a slide.

Analysis

Examine the surface of the filter under the highest power necessary to see the objects on the surface. To find out exactly how many organisms or objects are in each ml of your sample, perform the following steps:

a. Pick at random ten of the squares on the filter and count all of the objects or organisms in each square. (What you count and record depends on the nature of your problem.)

b. Substitute the number of organisms or objects counted in the following formula.

$$N = \frac{C \times 1380}{V \times 10}$$ where

N = number of organisms per ml
C = count in 10 squares of filter
1380 = filtering area in mm^2
V = volume of sample filtered
10 = number of squares counted

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Measuring The pH Of Water

Background Information

The pH scale expresses the relative concentration of hydrogen and hydroxide ions in a solution. When the concentration of these two ions in a solution is the same, the solution is said to be "neutral." When there are more hydrogen ions than hydroxide ions, the solution is said to be "acid." When the reverse is true, the solution is called basic.

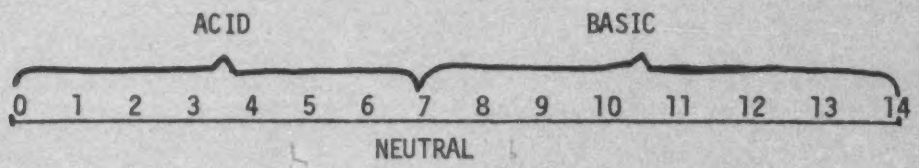

Figure 1. pH Scale

For a pH change of 1 unit, say 9 to 10, this requires a ten fold change in the concentration of hydrogen ions.

The pH of most natural waters will usually fall between the range of pH 4 to 9. Certain kinds of isolated waters such as bog-type lakes are notable exceptions. Most natural waters tend to be slightly basic due to substances that enter the water from the surrounding rocks, soil or air. Measurable differences in pH can be caused by the entry of waste materials from a variety of sources. Most living things in water are adapted to a particular range of pH values and drastic changes in these values can be harmful or lethal.

Materials and Equipment

This materials list contains suggestions for more than one method of measuring pH. Read over the procedures first to select the method that suits your level of required accuracy, the physical situation in which you will perform your tests and your pocketbook. (There is little profit in working to a higher degree of precision than your problem requires.)

a. pH Test Paper, 6 rolls short range (pH 1-14)

b. Wide Range Comparator (LaMotte) (pH 3-10). Other LaMotte comparators are available with different ranges and more precise standards.

c. Portable or laboratory pH meter from school or local environment. NOT RECOMMENDED FOR PURCHASE.

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Procedures

pH Test Papers

Papers are supplied in rolls in plastic dispensers. Withdraw and tear off approximately three inches of paper tape and immerse about 1 inch in test solution. Remove and promptly compare with standardized colors on side of plastic dispenser. Estimate pH by color comparison of strip to standard colors. pH estimates can be made to the closest .5pH with some confidence.

Color Comparator (LaMotte wide range)

The LaMotte comparator is a black plastic container that contains 8 sealed color standards, 2 openings for inserting samples, and 2 comparator tubes. It is used in the following manner:

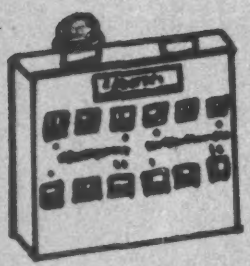
a.

Pour sample in cleaned comparator tube up to black line.

b.

Add five drops of wide range induator and mix by inverting one or two times.

c.



Insert comparator tube in comparator block and compare the color of the sample with color standards. Select the closest pH and estimate to the closest .25pH.

pH Meter

pH meters are of two general types, portable (battery operated) and laboratory or line operated. These instruments offer a much higher degree of precision than the colorimetric standards. The portable meter will normally yield results of ±0.1 pH units and the laboratory meter ±0.02 pH units. Directions vary with the unit and manufacturers, so no procedures are given here.

Color Comparison Tests For Nitrates Or Phosphates ((PO_4)) In Water

Background Information

Nitrates

Clean, natural waters rarely contain more than a tenth of a milligram of ammonia nitrogen per liter (0.1 ppm N) while community sewages commonly contain fifteen to fifty milligrams of ammonia nitrogen per liter. Most of this ammonia rises from the hydrolysis of urea in urine, but additional ammonia is generated by the decomposition of other nitrogenous materials in sewage. Sudden increases in the concentrations of ammonia found in streams indicate that sewage, barnyard wastes, or other high nitrogen substances are being added.

Intensive fertilization of high yield farm lands with concentrated nitrogen also raises the nitrogen content of runoff waters. Waters that are free of treated sewage may contain high nitrogen and produce heavy blooms of algae. The best available waste treatment may also supply water rich in nitrogenous materials.

Phosphates

Phosphate occurs in traces in many natural waters, from .01-.05 ppm and often in appreciable amounts during periods of low biologic productivity. Traces of phosphate increase the tendency of troublesome algae to grow in reservoirs. Waters receiving raw or treated sewage, agricultural drainage, and certain industrial waters normally contain significant concentrations of phosphate, anywhere from 5 to 30 ppm. Also, phosphate is frequently added to domestic and industrial waters in various forms. Trace amounts of phosphate may also be combined with organic matter. Such phosphate seldom exceeds a few tenths of a milligram per liter. Phosphate in its various forms may also appear in the suspended matter or sludge of the sample taken.

Materials and Equipment

Nitrates

LaMotte Nitrate Test Kit containing:
- 0.5 ml pipette, 1 ml pipette
- 0.1 g measuring spoon
- Nitrate reagent 1
- Nitrate reagent 2
- Nitrate reagent 3
- Nitrate reagent 4
- LaMotte Color Comparator, Phosphate-Nitrate (7492)

Phosphates

LaMotte Phosphate Test Kit containing:
- 1.00 ml pipette, and standard unmarked pipette
- VM Phosphate reagent
- VM Reducing reagent
- Comparator, 7492 (as above)

Procedures for Nitrates

Collect water to be sampled. (Portable test kits allow field sampling). Take the black plastic comparator from the test kit.

a. b.

a. Remove one of the red-capped test tubes, make sure it is clean, and fill to the black line with your water sample.

b. Using the 0.5 ml pipette, add one measured amount (to the 0.5 ml mark) of Nitrate Reagent 1 to the test sample..

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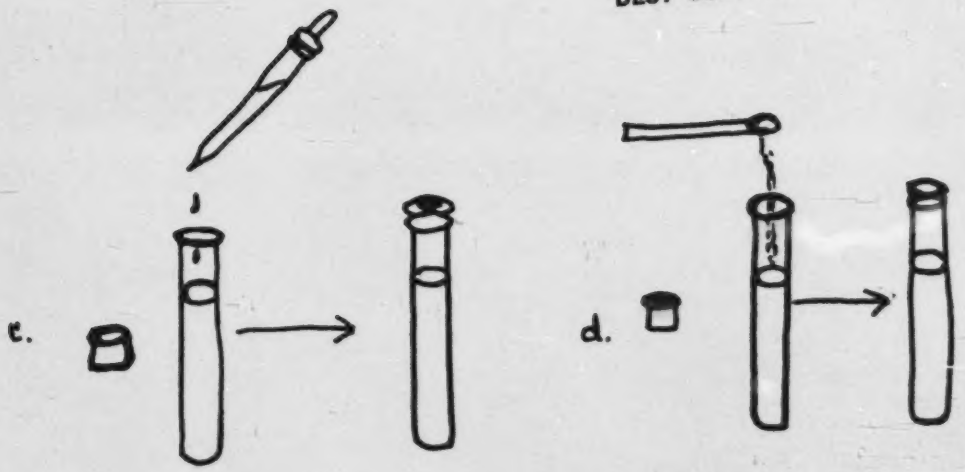
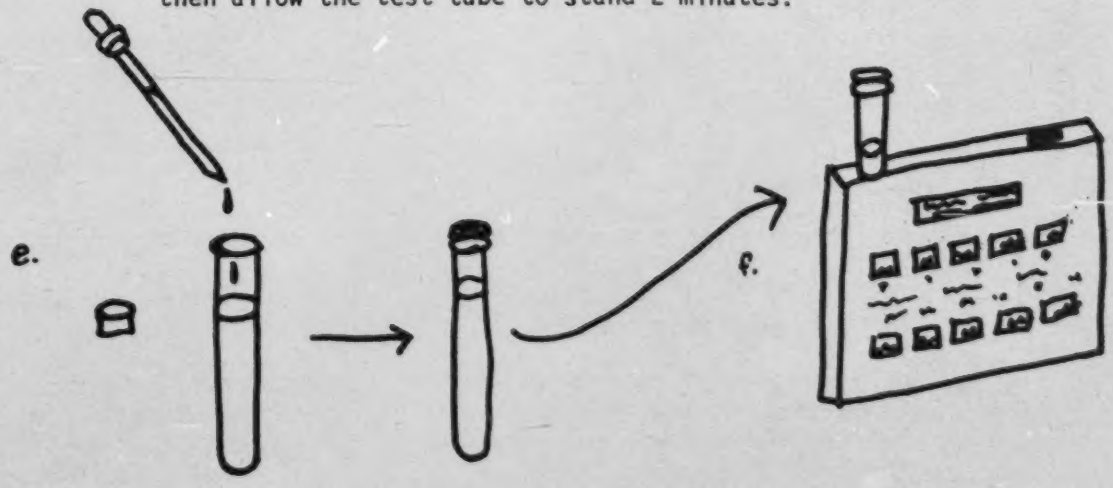


c. Using the 1.0 ml pipette, add one measured amount of Nitrate Reagent 2 to the test sample and mix the contents of the test tube. NOTE: Nitrate Reagent 2 is a Hydrochloric Acid Solution and should be handled with great care.

d. Using the 0.1 g measuring spoon, add one level measure of Nitrate Reagent 3 to the test sample. Stopper the test tube - and invert the tube 20 to 25 times to mix the contents and then allow the test tube to stand 2 minutes.



e. Using the 0.5 ml pipette, add one measured amount of Nitrate Reagent 4 to the test sample and mix.

f. After five minutes, if pink color develops, place tube in left (nitrate) side of comparator. Hold up to light source (preferably daylight) and match sample with standardized colors. Nitrate concentrations are given on the side of the comparator. An in-between color can be interpreted as halfway between the two values.

Procedures for Phosphates

NOTE: The test should be run on clear samples only. Filter the sample if necessary. See nitrate instructions for use of the cobalt comparator.

Single Reagent System (range 10 to 80 ppm)

a. Fill the test tube to the mark with water to be tested.

b. Using the 1.0 ml pipette, add one 1.0 cc of VM Phosphate Reagent to the test sample. Mix the contents of the tube.

c. Wait five minutes for full color development, then insert the tube in the comparator and compare the color of the test sample with the color of the standards of known value. When the color of the test sample is between the colors of two values, it is taken as an average of the two values.

d. Multiply the results obtained from the comparator by 10 to determine the phosphate level. If the level is less than 10 ppm, save the test sample and go on to the Two Reagent System, Step c.

Two Reagent System (range 1.0 to 10.0 ppm)

a. Fill the test tube to the mark with the water sample.

b. Using the 1.0 ml pipette, add one cc of VM Phosphate Reagent to the test sample and mix the contents of the tube.

c. Wait for five minutes, then using the unmarked pipette add three drops of VM Reducing Reagent and invert the tube to mix the contents. The color will develop immediately.

d. Insert the sample tube in the VM-12 Phosphate Comparator (4414) and compare the color of the best sample with the colors of the known standards. A test sample with a color that appears to be between two values is taken as an average of the two values.

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E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental: Integrated with:

CONCEPT NO. 5 - Air SUBJECT Biology

ORIENTATION Clean Air TOPIC/UNIT Corrosion

BEHAVIORAL OBJECTIVES

Cognitive:

Determine several effects of pollutants in the air at different areas in the community. Describe actions that can be taken to reduce the effects of the air pollutants. Compare cost of removing air pollutants with the costs of actions to reduce the affect of air pollutants.

Affective:

Recommend improvements in community control of air pollution in a class discussion. Convince others that the cost of reducing air pollutants is less than the cost of the results of air pollutants.

Skills Used:

Visual observation and determination of effects of air pollution.
Construct apparatus to measure air pollution.

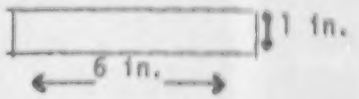
STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Discussion of effects of air pollutants on paint, wood, metals, etc.

Outside or Community:

1. Corrosion test panels made from aluminum foil strips can be placed outdoors at various locations around the school and community. Similar test panels can be placed inside closed jars at same locations. Particulate collectors at the same sites can give additional data. Compare visually. Determine: Which areas are most corrosive? Which areas have the most particulate matter? Is the particulate matter corrosive? Is corrosion a problem and what can be done about it?
2. Studs should be 1" in width and 6" in length.



SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Modern Biology, Otto & Towle, P. 729-731, Holt, Rinehart and Winston, 1969. High School Biology, BSCS Green Version, 2nd edition, pp. 764-770. **Audio–Visual:** Filmstrip: Environmental Pollution, Ward's Inc., 1969. Film: The 2nd Pollution, I-C-E RMC, #460. **Community:**	BEST COPY AVAILABLE

E. S. E. A. Title III — PROJECT I-C-E 59-70-0135-4

Environmental:

Integrated with:

CONCEPT NO. 5 - Air

SUBJECT Biology

ORIENTATION Clean Air

TOPIC/UNIT Microbiology

BEHAVIORAL OBJECTIVES

Cognitive:

Identify varieties of micro-organisms through visual observation in various air samples and count number of colonies present in each. Predict the type(s) and number of microorganisms present in agar plates placed in areas similar to those in the learning situation.

Affective:

Accept the fact that another dimension of air quality is microorganism content.

Skills Used:

Bacteriological techniques.

STUDENT-CENTERED LEARNING ACTIVITIES

In-Class:

1. Prepare several petrie dishes of nutrient agar. Have student open plates and expose agar to air in several locations for a period of 10 minutes. Incubate plates for 24 hours. Have students observe and record kinds of colonies and number of colonies in each location.

Outside or Community:

1. Can have students expose agar plates in various locations around community. Also record weather data and attempt to relate weather, location, and bacterial growth in data discussion.

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Biological Science: Molecules to Man, BSCS Blue Version, 2nd ed. High School Biology, BSCS Green Version, 2nd ed. **Audio–Visual:** Bacteria, BAVI. **Community:** Air samples.	Comment: Millipore has an excellent small system for analysis of airborne microorganisms. Catalog is available from Millipore Corp., Medford, Mass. 01730

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental: **Integrated with:**

CONCEPT NO. 6 - Resources **SUBJECT** Biology

ORIENTATION Plants, Natural Resources **TOPIC/UNIT** Investigation of Biotic Community

BEHAVIORAL OBJECTIVES

Cognitive:

Determine how he can best sample a given quadrat (study area). Sample the area for vegetation types using the quadrat technique and graphically illustrate the distribution. Identify several environmental factors which contribute to distribution of plant species.

Affective:

Suggest means of limiting detrimental factors to the distribution of plant species.

Skills Used:

Developing sampling technique.
Sampling.
Presenting data in graph form.
Identifying plants.
Use of keys.
Charting-samples-visually/artistically.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Discussion of sampling techniques. Identification procedures.

Outside or Community:

1. Upon selecting an area for study, the student will determine how to sample an area, have it approved by the teacher than sample the area. Bring in a sample of vegetation types where possible or identify in the field. If positive identification cannot be made, use plant form; broadleaf, narrowleaf, etc.

   Some suggestions for sampling might be to toss a hula-hoop over your shoulder. Or by a more positive transect through the area.

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES

Publications:

The Study of Plant Communities, Freeman & Co., 1956, Ch. 3-4.
Some Sampling Characteristics of a Population of Randomly-Dispersed Individuals, Ecol. 34, pp. 741-757, 1957.
High School Biology, BSCS, Green Version, 2nd Ed., Chapter 3.

Audio–Visual:

Film Loop - Mountain Trees - An Ecological Study, BSCS.

Community:

Art teacher for graphic illustration.

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Environmental:

Integrated with:

CONCEPT NO. 6 - Resources

SUBJECT Biology

ORIENTATION Food as a Resource

TOPIC/UNIT Food Chain

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

BEHAVIORAL OBJECTIVES

Cognitive:

Calculate amount of different kinds of food needed to sustain a person for a period of time. (day, week, etc.) Demonstrate ability to determine foods that are low on the food pyramid by listing several of these foods.

Affective:

Challenge the idea that many people have, that what is done to one level of the food pyramid does not affect other levels.

Skills Used:

Calculation of calorie needs of man, calculation of efficiency of trophic levels.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Students can be assigned to estimate weight of meat or plant material needed to sustain a human adult.
2. With this in mind, student should be able to show how man's habit of eating high on food pyramid (meat) is much less efficient in an ecosystem than his subsisting on grains (for example) lower on food pyramid. Why are these foods used? (food value, taste, convenience, cost)
3. Student should also examine food content (energy source, essential amino acids, trace elements, vitamins).
4. Present panel discussion on human tradition on selecting foods.
5. Keep log of food consumption.
6. Students through experimentation can determine calorie content of various foods.

Outside or Community:

1. Visit local slaughterhouse.

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Ecology Text should provide estimates on biomass or caloric content of bypothetical food pyramid. Biological Science: Patterns and Processes. BSCS, Revised Ed. NASA: Nutrition and Food Utilization National Aeronautics & Space Adm. Famine 1975. **Audio–Visual:** World population figures. Film: Population Ecology, BAVI. **Community:** Home economics teacher.	

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E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 7 - Land Use

SUBJECT Biology

ORIENTATION Man's Effect on Natural Resources and Community

TOPIC/UNIT The Human Species

BEHAVIORAL OBJECTIVES

Cognitive:

identify and site evidence for an environmental problem of destruction of natural resources: air, land, water, scenic beauty, by industry, highway builders, sign clutter, overpopulation, etc. within his own community.

Affective:

Propose at least one justification for preservation of environment over progress upon completion of this lesson.

Skills Used:

Recognition of problems.
Reporting.
Discussion (communication skills)
Gathering information.
Preparing reports.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. The teacher will present Part IV Preserve and Protect from Crisis of the Environment.
2. Make a map of the state and National Parks and Forests in your state.
3. Write a history of the establishment of a national park.
4. Report on a bill before Congress in the current session which deals with preservation of wilderness or conservation of natural resources.
5. Report on the Wild Rivers Bill which sets aside rivers, as the Wolf in Wisconsin.
6. Send a letter expressing your views about a current conservation dispute to the appropriate government official.
7. Write a paper on what wilderness means to you.
8. Write a government or private conservation agency, and find out what it does.

(Continued)

Outside or Community:

1. The student will study a problem within his community, for example, a conflict of use of a park area, a proposed road, etc., and report on same.

SUGGESTED RESOURCES

Publications:

The Quiet Crisis,
Stewart Udall, Avon 1967.
America the Raped,
Gene Marine,
Simon and Schuster, 1969.
Sierra Club Bulletin,
The Sierra Club, monthly.
National Parks Magazine.
Sand County Almanac,
Aldo Leopold.

Audio-Visual:

Eyegate Series,
Aggradation-Degradation.

Community:

Local conservation agency.
Local conservation groups.

CONTINUED OR ADDED LEARNING ACTIVITIES

CLASSROOM: (Continued)

9. Teacher should make a map of community area without roads, streets, bridges, etc. Perhaps produce a map attempting to show what the natural scene was like before the community was established. The students after being given this map and symbols for houses, factories, bridges, roads, etc., should be able to construct a model city. Their city should be void from as many environmental problems as possible. A class discussion having students defend their model city is very stimulating and beneficial to the group.

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental: **Integrated with:**

CONCEPT NO. 8 - Values and Attitudes **SUBJECT** Biology

ORIENTATION Man's Effect on the Ecosystem **TOPIC/UNIT** Man's Values

BEHAVIORAL OBJECTIVES

Cognitive:

Discuss critically, in writing, at least one factor involved in bringing us down this path of tragedy upon completion of reading A Fable For Tomorrow from Silent Spring. Explain several methods that can be used to change man's values so that he will be more receptable to efforts to combat the pollution problem.

Affective:

Demonstrate awareness of how man's ambitiousness sometimes leads to environmental deterioration by citing examples. Advocate a change in man's values as necessary in order to satisfactorily combat the pollution problem.

Skills Used:

Examining.
Suggesting.
Discussing.
Propose reasons.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Read A Fable For Tomorrow, Chapter 1 of Silent Spring, then write a paragraph of at least one factor involved in bringing us down this path of tragedy.
2. Discuss the various factors proposed by the students of your class.
3. Read and write or orally report on Since Silent Spring by Frank Graham, Jr.
4. Urge your students to observe specific problems of their immediate environment. Report in class on the particular problem and suggest various alternative ways of solving the problem.

Outside or Community:

A. Library
   1. Do a library research project on pesticides, use and regulation.

B. Community
   1. Discuss the pesticide regulations for your area with a Dept. of Natural Resources agent, county agent, farmer, florist, etc. and report to your class.

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Since Silent Spring, Frank Graham, Jr., 1970. Silent Spring, Rachel Carson. Third Generation Pesticides, Carroll Williams-Scientific American, July, 1967. Reader's Digest, June, 1959. Science and Survival, Barry Commoner, N.Y., 1966. **Audio–Visual:** Crisis of the Environment, Part II, Breaking the Biological Strand. Films: Pesticides in Focus, Shell. Food or Famine, Shell. **Community:** School Ag. Instructor. Local DNR official to discuss DNR roll in Environmental Quality.	

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 9 - Management **SUBJECT** Biology

ORIENTATION Man's Influence on Land Change **TOPIC/UNIT** Man in the Ecosystem

BEHAVIORAL OBJECTIVES

Cognitive:

Describe two factors that significantly control life forms in major biotic regions and correlate these with the community structure of a native vegetative site.

Affective:

Criticize the role of man as a change agent on native biotic regions as being detrimental to the native floras and faunas in many instances. Praise the efforts of groups and individuals, i.e. Conservation, Inc., Trees for Tomorrow, etc., for their efforts in changing man's role as a change agent.

Skills Used:

Construction of climatograms.
Correlation between environment and biota.
Correlation between flora and dependent fauna.
Observation.
Independent library research.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

A. Unit study area: major communities, biomes, and biogeography.
   1. Students construct climatograms of several selected locations representing major biomes.
   2. Students investigate the vegetational elements of a biome and the relationship between climate and vegetation (use film).
   3. Students investigate the animal components of the selected biomes.
   4. Discuss adaptations of plant and animal to a biotic region.
   5. Application: By report or discussion, students connect the change in vegetation in a biotic region with man's activities, both planned and unforeseen.

Outside or Community:

A. Outside.
   1. Field trip suggested to site of relic vegetation representative of our local biome (mid-latitude deciduous forest). Contract with vegetation in the region affected by man.

B. Library.
   1. Students do outside readings on man's effects on native biomes from current periodical literature or paperbacks on environmental problems.

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: P. Dansereau, Biogeography: An Ecological Perspective. Odum, Fundamentals of Ecology, J. H. Curtis, the modifications of mid-latitude grassland and forests by man (In) Man's Impact on Environment - Detwyler, (Copies available in CESA #9 office) **Audio-Visual:** (Student level) Who Needs a Swamp? Gene Marine (In) America, the Raped, Avon, $1.25. Film: The Temperate Deciduous Forest, Encyclopedia Brittanica Films. **Community:** Residual stands of old growth forest or reasonable facsimiles.	

E. S. E. A. Title III – PROJECT I-C-E 59-70-0135-4

Environmental: **Integrated with:**

CONCEPT NO. 10 - Economic Planning **SUBJECT** Biology

ORIENTATION Man's Use of Fertilizers **TOPIC/UNIT** Man in the Ecosystem

BEHAVIORAL OBJECTIVES

Cognitive:

Trace the fate of commercial fertilizers through an ecosystem by preparing an essay on fertilizer pathways based on his library research. Predict the affect of using commercial fertilizer, on given cropland areas, on the overall environment during the next five years.

Affective:

Discuss the relationship between immediate profit goals and long-term environmental damage costs with others. Revises his judgment that the use of additional fertilizer is very beneficial to the environment.

Skills Used:

Ability to relate some common human activity to changes in a lake environment.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Students write an essay in which they follow logically the fate of commercial fertilizers used by farmers on fields. This should allow them to see that excessive use of these substances must enrich the waters of local lakes or rivers. They should consider what effect this has on plant and animal life. They should arrive at the conclusion that man can and does hasten eutrophication.
2. Students will suggest in discussion why fertilizers might be applied in rates above the capacity of soils to attempt and hold free ions from the soil solution. Teacher leads the discussion of value systems that are shortsighted and directed to immediate profit return without concern for long-term and cross boundary effects.

(Continued)

Outside or Community:

1. Sample various water areas for evidence of algae growth, water clarity and micro-organism density. This would indicate the presence of nutrients in varied amounts. (Do so when water temperature is above 20°C.)

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Modern Biology, Otto Towle, Ch. 49. High School Biology, P. 243, BSCS, Green Version. **Audio-Visual:** Filmstrip: N. Y. Times, 1970, Crisis of The Environment. Land Pollution #3 of Environmental Pollution, Wards. LaMotte or Hach Water Testing Kit. **Community:** Farmers Viewpoint. County Agriculture Agent. DNR Representative.	CLASSROOM: (Continued) 3. Students using LaMotte or Hach water testing kits can test water samples at various runoff locations for nitrates and phosphates. Follow with discussion on the effects of nitrates and phosphates on algae growth.

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 11 - Individual Acts

SUBJECT Biology

ORIENTATION Biological Magnification

TOPIC/UNIT Man in the Ecosystem

BEHAVIORAL OBJECTIVES

Cognitive:

Describe several examples of biological amplification of pesticides encountered in a review of source literature and relate this to pesticide half-life. Explain the detrimental effects of using pesticides, incorporating the food pyramid in the explanation.

Affective:

Express concern over individual contributions to pesticide pollution. Suggest measures that will guide individual decisions on pesticide use in agreement with ecological principles.

Skills Used:

Observation.
Data recording.
Data analysis.
Correlation of written research and direct lab observation.
Application to real world problems.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Review with class the concept of a food chain.
2. Student lab work in teams of 3-5. Set up a controlled artificial pond experiment.
   a. In a glass jar exposed to daylight, introduce a culture of planktonic algae in a balanced nutrient solution.
   b. After a week approximately, make a cell count with a plankton counting chamber.
   c. Introduce a known population of Daphnia or other zooplankters. Make daily cell counts over a week's time.
   d. Introduce a small minnow type fish in the jar. Take care to adequately aerate. After a day or so, count the zooplankters.
3. Discuss the food pyramid concept and its implications as exemplified by the experimental results summarized for the class as a whole.

(Continued)

Outside or Community:

1. Investigate the types of pesticides sold in local stores for effective chemical formulation. Check available literature for reference to break down time and biological concentrate-ability of most commonly used insecticides and herbicides.

SUGGESTED RESOURCES

Publications:

Pesticides and the Living Landscape, Robert Rudd, U. Wis., Press.
Cleaning Our Environment: The Chemical Basis for Action, American Chemical Society.
Man's Impact on Environment, Thomas Detwyle, McGraw-Hill.
Silent Spring, Rachel Carson.
Science, appropriate article.
Bioscience, appropriate articles.
Biological Science: Molecules to Man, 2nd Ed., BSCS Blue Version.

Audio-Visual:

Film:
Food Cycle and Food Chains, 11 minutes, $4.00, UW-LaCrosse Film Library.

Community:

Local pond and pools with algae and Daphnia populations.

CONTINUED OR ADDED LEARNING ACTIVITIES

CLASSROOM: (Continued)

4. Students read short selections on the principles of biological amplification or delayed expression known to occur as pesticides are concentrated in the food chain terminals. Discuss the relationship between chlorinated pesticides and fat tissue.
5. Apply the correlation obtained between the pyramid of numbers and biological amplification to man's role as source of pesticide contamination. Emphasize in guided discussion, the role of individual farm operator, municipality, and corporation in compounding the availability of pesticide to the biosphere as a whole.
6. Students suggest ways individual decisions can be guided to be in agreement with the whole ecosystem operation stability.
7. As an alternate students through experimentation, can trace radioactive phosphorus through a food chain. (BSCS: Blue Version, 2nd ed., page 778) Radioactive elements can be purchased from Abbott Labs, Chicago, Illinois.

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental: **Integrated with:**

CONCEPT NO. 12 - Stewardship **SUBJECT** Biology

ORIENTATION Conservation of land Resources **TOPIC/UNIT** Man and His Environment

BEHAVIORAL OBJECTIVES

Cognitive:

Explain the effects of animal activities on water infiltration and runoff of compacted soil. Formulate a management program for a given area and conditions that will incorporate the principles of infiltration of water and growth of plants.

Affective:

Question the use of various agricultural practices which tend to decrease the rate of water infiltration and subsequent increased runoff upon completion of this investigation. Propose management program for a given area and conditions that will minimize the destruction of the resources of land and water.

Skills Used:

Observation.
Experimentation.
Control (experimental).
Comparison.
Gathering data.
Presenting data.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

GENERAL RATIONALE:

The grazing of domestic animals in an enclosed area of native vegetation often brings about great changes in species composition of the communities present. These changes include destruction of many of the original plants, the introduction of many plants not members of the undisturbed community, and a number of changes in the soil of the grazed area. The soil change which is most pronounced is that resulting from compaction by the animals' hooves. This results in a greatly reduced rate of infiltration of rain water and a consequent increase of runoff.

A. Student-centered activity could be discussion on several current environmental issues. Example questions:
   1. Do owners of snowmobiles practice good stewardship?

(Continued)

Outside or Community:

A. Class Project:
   1. Soil compactness may be measured with fairly sophisticated equipment such as a Wilde Permeater. Less sophisticated equipment is adequate for the purpose of this investigation. The student will first remove both ends of a small frozen juice can. Insert the can 2 inches into the soil. Pour in 50 ml. of water into the can and record the length of time required for the water to enter the soil. Study a pair of communities, one grazed, one ungrazed. A school playlot vs. a lawn may be used. Measure the water infiltration rate in the two sites. Submit a brief summary of your observations.

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES

Publications:

E. C. Steinbrenner
Effects of grazing on floristic composition and soil properties of farm woodland in southern Wis. Journal Forestry, 49:906-910, 1951.
Sand County Almanac, Leopold.

Audio–Visual:

Film:
Tragedy of the Commons,
Holt, Rinehart & Winston, Inc.
383 Madison Avenue
New York, N. Y. 10017

Community:

Local farmer.
Soil Conservation Board Rep.

CLASSROOM: (Continued)

A. 2. Does a land owner living on a lake have the right to pollute the water?
3. At a time when fuel shortages appear to be evident, should people who own boats be allowed to use them as a recreational device?
4. Should sales people who are on the road be allowed more gasoline than the average citizen?
5. Does industry, even though it provides jobs for people, have the right to pollute land, water, and atmosphere?
6. Should sports fishing on Lake Michigan be stopped so that commercial fishing can provide a more attractive income for those people employed in the business?

Environmental: **Integrated with:**

CONCEPT NO. 1 - Energy **SUBJECT** Advanced Biology

ORIENTATION Energy Use * **TOPIC/UNIT** Photosynthesis

BEHAVIORAL OBJECTIVES

Cognitive:

Contrast the effect of the sun-energy-photosynthesis reaction with the respiration use of energy by testing the oxygen production of algae in the light and dark.

Affective:

Judge that sunlight energy is essential for all life by applying test results to the general question of the photo-synthesis-respiration-energy equation.

Skills Used:

Observation and data collection.
Measurement.
Lab procedure.
Interpreting data.
Inductive reasoning.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

A.

1. Use a cultured batch of algal-enriched water or a reasonably algal-enriched batch of pond water. Mix well and fill 3 B.O.D.-type bottles.
2. Test one bottle for dissolved oxygen (D.O.); to check the baseline D.O. use the Hach Kit or standard Winklers method for D.O.
3. Cover one B.O.D. bottle with aluminum foil to exclude all light.
4. Submerge this and the remaining B.O.D. bottle in a pan of water. Fill to necks. (Water maintains even temperature) Leave for 30 minutes to 2 hours in well-lighted area.
5. Remove B.O.D. bottles, run D.O. test, and calculate both positive and negative from baseline D.O.
6. Total addition of D.O. is calculated by calculating difference between light and dark bottles to give gross primary productivity.

Outside or Community:

(Continued)

SUGGESTED RESOURCES

Publications:

Welch. Limnological Methods.
Reid. Ecology of Inland Waters and Estuaries.
Ruttner. Fundamentals of Limnology.
Resource: 13th Edition. Methods of Wastewater Treatment, U. S. Public Health Service.

Audio-Visual:

Hach Chemical Kit - Dissolved Oxygen.

Community:

Local ponds.

CONTINUED OR ADDED LEARNING ACTIVITIES

Classroom: (Continued)

A. 6. Net productivity in the light is calculated from the difference between the light bottle reading and baseline D.O. Net respiration is the difference between the dark bottle reading and baseline D.O.

B. If a pure algal culture without zooplankter grazers is used, rate of change of standing crop can be calculated.
   1. Using a well-mixed algal culture sufficiently diluted to be below carrying capacity, filter one aliquot thru a fine-grade filter, air dry, and weigh.
   2. Let another equal aliquot stand several days in a well-lighted area, filter, air dry, and weigh. Compare the weight difference to find the increase in the standing crop. (Note: Algal growth on the side of the beaker must be scraped and added to the filter with a distilled water medium. Accuracy of this test will depend on filter qualities and scale accuracy.) Use of a balance sensitive to 0.01g is desirable.

C. Discuss the implications of the sunlight role in increasing dissolved oxygen and standing crop.

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E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental: **Integrated with:**

CONCEPT NO. 1 - Energy **SUBJECT** Advanced Biology

ORIENTATION Effect of Air Pollution on photosynthesis * **TOPIC/UNIT** Photosynthesis

BEHAVIORAL OBJECTIVES

Cognitive:

Measure, record, graph, and compare the photosynthetic properties of plants growing under simulated or actual clear and polluted air conditions using oxygen production and dry weight as experimental criteria.

Affective:

Advocates legislation and enforcement of methods designed to remove light absorbers from the atmosphere by writing to their legislators proposing such laws. Attempt to compare polluted air and clear air photosynthetic rates to impress upon other students the fact that air pollution threatens the basic needs of society.

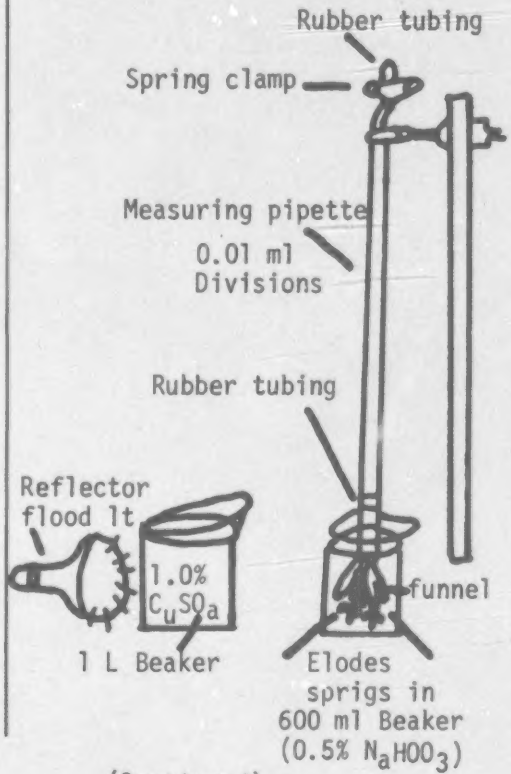
Skills Used:

Experimentation with plant materials providing opportunities to collect data, analyze those data, and present a conclusive report regarding the dangers of air pollution.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Classroom Experience - EFFECT OF LIGHT INTENSITY ON PHOTOSYNTHETIC RATE.
   Set up apparatus as shown below:



(Continued)

Outside or Community:

EFFECTS OF POLLUTED AIR ON PHOTOSYNTHETIC RATE.

1. Establish correspondence with a high school biology department located in a heavily industrialized area.
2. Determine dates, times and recording and experimental standards which will be used by your experimental team and the "correspondence team."
3. Set potted coleus plants in outside planters and allow them to become acclimated.
4. Measure as many environmental factors as you can during the experiment. For later correlation:
5. Begin the experiment as early in the day as possible.
6. Using a No. 9 cork borer, cut 62 discs (1 sq. decimeter) each from the leaves of five coleus plants.
7. Be sure to leave enough unsampled leaves for later experimentation.
8. Label the samples and place in an oven at 105° for several days.

(Continued)

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SUGGESTED RESOURCES

Publications:

Meyer, Anderson, and Swanson, Laboratory Plant Physiology, D. Van Nostrand Co., Inc., N.Y. '55.
Strafford, G.A., Essentials of Plant Physiology, Heinemann Educ. Books, Ltd., London, 1965.
Rosenberg, Jerome L., Photosynthesis, Holt, Rinehart & Winston, Inc. N.Y. '65.
Phillips, Edwin A., Field Ecology, D.C. Heath & Co., Boston, 1964.
Humphrey, Van Dyke, and Willis, Life in the Laboratory, Harcourt, Brace & World, Inc., N.Y. 1965.

Audio-Visual:

Filmstrip Series: Crisis of the Environment, New York Times Book and Educational Division.
Film:
The Answer is Clear, Shell Oil.
Air Pollution, $4.00 U.W.-LaCrosse Film Library.

Community:

CONTINUED OR ADDED LEARNING ACTIVITIES

Classroom: (Continued)

2. Use a 300 watt lamp.
3. Cut bases of two elodes sprigs diagonally and place in funnel with bases near the funnel stem.
4. Release the spring clamp and apply mouth suction through rubber tube until the water level is near the top of the pipette.
5. Reclamp the rubber tubing. (If the water level drops, there is an air leak and the apparatus must be checked.)
6. Turn on the floodlight.
7. When the first bubbles appear, record the time and water level.
8. Record water level again 15 minutes later. (Subtract final reading from initial reading.)
9. Calculate photosynthetic rate in milliliters of oxygen released per hour.
10. Substitute a 150 watt lamp and repeat the experiment.
11. With a bar graph, graph the results of this experiment.
12. There are 2.7×10^{19} molecules of oxygen/milliliter of volume. An average of 6 oxygen molecules are released for each glucose molecule synthesized. Calculate how many glucose molecules have been produced/hour at each of the two light intensities.
    Question for Analysis: The City of Chicago at times, exists-under only 55-60% of the available sunlight due to pollution-laden skies. How does this information pertain to the experiment just completed? An alternate to the above experiment is the substitution of algae-rich water in the first (1 L) beaker as the second test using the 300 watt bulb for both tests.

Outside or Community: (Continued)

9. Repeat the cutting and drying late in the afternoon (before sunset).
10. Weigh cuttings with an analytical balance.
11. Repeat this experiment once each week for five weeks.
12. Calculate the increase of dry weight in milligrams/hour and in milligrams/decimeter^2 hours.
13. Graph a comparison of your data with those from the cooperating school.
14. Write a conclusive analysis of the effects of air pollution on photosynthetic rate.

(Continued)

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Audio–Visual: Community:	Outside or Community: (Continued) FIELD ACTIVITY: Effects of Polluted Air on Photosynthetic Rate: 1. Select two sites: one located in a clean-air region and one located near a solid waste burning area. 2. Select a species of shrub growing in similar habitats in each location. 3. Repeat experiment #2. (Effects of polluted air on photosynthetic rate.) 4. Use a Ringelmann Scale to measure blackness of smoke from burning dump. 5. Record observable signs of photosynthetic blockages (soot on leaf surfaces; burns; etc.). 6. Make calculations, graphs, and analysis as in experiment #2. (Effects of Polluted Air on Photosynthetic Rate.)

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E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental: **Integrated with:**

CONCEPT NO. 2 - Ecosystem SUBJECT Advanced Biology

ORIENTATION Natural Interaction - Plants and Bacteria * TOPIC/UNIT Ecosystem

BEHAVIORAL OBJECTIVES

Cognitive:

Measure, record, and compare dry weight, plant size, and color of legumes grown in the presence and absence of nitrogen-fixing bacteria.

Affective:

Object to and record any attempt to prevent the natural interactions in a biotic community in his local area.

Skills Used:

Setting up a scientific investigation.
Collecting and validating data.
Be able to draw valid written conclusions from results of experiment.

(Continued)

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Class Experiment - You will need: seeds of a leguminous plant, chlorox, pots of soil, and nitrogen-fixing bacteria (obtained either from growing legumes or from a commercial source such as feed and seed store or farm supply). Students will plan a procedure after considering the following:
   a. Where in nature would you seek the bacteria?
   b. How may you be reasonably sure that some of your legumes have been deprived of the nodule bacteria?
   c. Are you going to use sterilized soil? Explain.
   d. Have you considered surface sterilization of the seeds? Explain.
   e. Does your procedure require the innoculation of seeds, of soil, both?
   f. What procedures will you follow during the growing period?
   g. What standards will you use in comparing the plants?

(Continued)

Outside or Community:

1. Supplementary reference work in the library.
2. Contact representatives from one of several available agencies (e.g. county agent, Midland Coop. or Agricultural Records Coop.).
3. Lecture-discussion with outside speaker; emphasis on affects of man-made chemicals on the soil bacteria and consequently on food production of legumes.
4. Follow-up with the field study as follows:
5. Field Activity: Effects of man-made chemicals on the growth of legumes.
   a. Obtain permission to experiment on a limited area, on or near the school grounds (if possible a 30' x 30' plot). The area must have well established leguminous plants.
   b. Class can be divided into teams of convenient size (2-4 students per team).

(Continued)

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SUGGESTED RESOURCES

Publications:

Laboratory and Field Studies in Biology, by Lasson, Chester A. Paulson, Richard E., Holt, Rinehart & Winston, Inc., New York, 1958.

Audio-Visual:

Community:

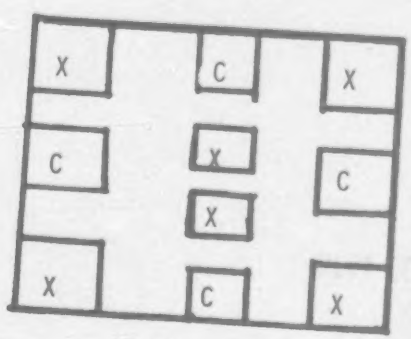
CONTINUED OR ADDED LEARNING ACTIVITIES

Skills: (Continued)
Creation of experimental procedures involving aspects of the environment.
Accurate recording of data.
Construction of easily-interpreted graphs of recorded data.
Ability to analyze data and suggest possible conclusions.

In-Class: (Continued)
2. Plant your seeds. Record facts observed, using the standard you devised. Observations should be made weekly for at least a 6-week period. Drawing conclusions:
   a. Are the nodules really the result of bacterial activity?
   b. Are all bacteria, or only certain kinds of bacteria, capable of causing nodules?
   c. How useful is this cooperative arrangement to the legume, to the bacteria?
   d. How useful is this cooperative arrangement to man?
   e. Does the use or overuse of pesticides or herbicides affect this relationship?
   f. Does the use or overuse of fertilizer affect this relationship?

Outside or Community: (Continued)
5. c. Each team will select one experimental variable of the many possible variants. (Example, insecticides, herbicides, detergents, fertilizers--commercial and natural, etc.)
   d. The 30' square plot may be divided as in the following diagram:

x - experimental
c - control



(Continued)

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications:	Outside or Community: (Continued) 5. e. Method of application must be determined by each team. f. Results may be recorded on a chart similar to the one below: Team No. _____ Experimental Variable _____
Audio–Visual:	*Because it is necessary to use a constant color guide, a suggestion is to use a painter's color chart of applicable shades of green and yellow. g. Running time of the experiment can be left to the teacher's disgression but at least four weeks is recommended. h. Graphing of data can be limited only by the student's imagination. Certainly dry weight and size can be graphed. Can color be illustrated graphically? i. After student group discussion and anlaysis, the results of this open-ended experiment should be written up in a manner acceptable to the teacher.
Community:	

Date	Average Height (Ground to Tip)	Color*	Average dry weight at conclusion of experiment

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 3 - Carrying Capacity

SUBJECT Advanced Biology

ORIENTATION Population Growth

* TOPIC/UNIT Populations, Societies, and Communities

BEHAVIORAL OBJECTIVES

Cognitive:

Demonstrate a procedure, given an opportunity to develop a project, to research, select, conduct, analyze, and write a report on the outcome of his particular experiment on behavior in crowded situations.

Affective:

Accept a personal responsibility for the control of future human population. Attempt to compare the actions of humans in an overcrowded situation to the actions of animal societies.

Skills Used:

Experiment selection and development.
Observation and evaluation of experimental data.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Research - Class project involving research pertaining to effects of crowding in natural animal communities.
   a. Discussions involving crowding effects on animals in simulated "slum" areas.
   b. Selection of variable-length projects to be undertaken by teams of 2-6 students.**

Outside or Community:

1. Panel discussion involving faculty members from social studies, area studies, sociology, psychology, or behavioral sciences within the school system. Discussion of man's desire "to get away from it all."
2. Students will develop their ** projects and record unusual behavior in crowded situations.
3. Field Experiences (or lab).
   a. Start pair of mice in container of predetermined size (feed, clean, and allow reproduction to occur at normal rate).
   b. Fruitfly cultures.
   c. Gerbil (as above for mice).
   d. Daphnia culture.
   e. Vinegar eel cultures.
   f. Guppies.

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Population Dynamics, John Cairns, Jr., Rand McNally Patterns of Life Series. The Population Bomb, Paul Ehrlich A Sierre Club/Ballantine Book. Man's Impact on Nature, Garden City, N. Y., Natural History Press, 1969. The Balance of Nature, Dubos. **Audio-Visual:** Film: #4706, Animal Predators and the Balance of Nature, $4.00, BAVI, 1968. **Community:** Faculty members.	

Environmental:

Integrated with:

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CONCEPT NO. 3 - Carrying Capacity

SUBJECT Advanced Biology

ORIENTATION Population Growth *

TOPIC/UNIT Microbiology

BEHAVIORAL OBJECTIVES

Cognitive:

Successfully culture, census, and analyze the growth of the population given any species of organisms and all necessary culturing and observing equipment. Construct a graphical representation of the growth phenomena. Analyze this data in terms of carrying capacity of a given environment.

Affective:

Accept a personal responsibility for the control of future human populations, by comparing and keeping a record on the increases in population of other organisms with that of humans, and suggesting ways that he can assist in controlling future population numbers.

Skills Used:

Observation of population. Analysis of collected data. Presentation of data and analysis in an organized and understandable manner.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Classroom Experience - Growth of a Yeast Population.
   PROCEDURE -
   a. Innoculate 1 liter of sterile water with 1 pkg. of dry yeast.
   b. After shaking the liquid to suspend the yeast cells uniformly, transfer 1 ml. of this stock to a flask containing 99 ml. of sterile H_2O.
   c. Shake the second dilution of yeast cells to form a uniform suspension. Transfer 1 ml. of the second suspension to each of two flasks containing 49 ml. of sterile culture medium.
   d. Each student should determine the number of yeast cells per ml. in the second (99 ml.) dilution flask by use of the hemocytometer counting chamber. (The count per large square, $1mm^2$, must be multiplied by 10,000 to yield cells per cc).

(Continued)

Outside or Community:

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SUGGESTED RESOURCES

Publications:

BSCS Writers, Biological Science Interaction of Experiments and Ideas, Prentice-Hall, Inc., Englewood Cliffs, N.J., 1965.
Thompson, Warren S., Population Problems, McGraw-Hill Book Co., Inc., N.Y. 1953.
Odum, Eugene P., Fundamentals of Ecology, W. B. Sanders Co., Philadelphia, 1966.
Sussman, Alfred S., Microbes, Their Growth, Nutrition, and Interaction, D. C. Heath and Co., Boston, 1964.

Audio-Visual:

Charts and graphs to be posted on the bulletin board.

Community:

Local math teacher to discuss the calculations involving population multiples and graphing procedures.

CONTINUED OR ADDED LEARNING ACTIVITIES

Classroom: (Continued)

1. d. This number represents population count in the culture at 0 hours, the starting time. Record in a chart similar to the following:

Date	Time of Day	Age of Culture	Cells/cc

e. Each team member should count and record the number of cells daily. The counts of all members should be averaged daily and recorded on a chart similar to the individual chart. (If the mathematical ability of the students permits, the counts should be recorded as exponents of 10.)
f. Continue the counts until the cultures are 10 days old.
g. Graph individual and team results. (Time is shown on the x-axis and number of cells on the y-axis.)

ANALYSIS:

A. Explain any variations in the team and individual growth curves.
B. Divide the curve into convenient phases and explain the factors causing the phases.
C. Compare the growth curve of the yeast population (in a closed environment) to the present human population curve and predict the anticipated destiny of the human population in terms of carrying capacity.

2. Classroom Experience - The Arithmetic of Microbial Growth. (Interaction of Disciplines)
Outside Speaker: Faculty member from school math department.

PROCEDURE -

a. Lecture-discussion of use of exponents to avoid awkwardness of large numbers.
b. Practice problems converting large numbers to exponents with 10 as the base. i.e., convert the following to exponential for 175; 9,673,000,000; 4,000; 0.003; 0.478; 0.00000078; 1/100.

(Continued)

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SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES

Publications:

Audio–Visual:

Community:

Classroom: (Continued)

2. c. Lecture-discussion of logarithms and antilogs.
   d. Practice in converting whole numbers to logarithms.
   e. Practice in multiplying and dividing logarithms.
   f. Problems in projected growth of microbial growth: i.e., a colony of paramecia was observed to double every hour. Starting with one organism, how many can be expected to be present in an unlimited culture medium after eight days?
   g. The use of logs, antilogs, and exponents will prove to be valuable aids in interpreting and analyzing population growths.
3. Classroom Experience - A History of Pond Organisms.
   PROCEDURE -
   a. Students will bring a sample of pond water into the classroom.
   b. While collecting sample, students will also collect abiotic factors: H_2O temperature, atmospheric temperature, photo-period (time of daybreak and dusk), light intensity (average), ph of water.
   c. Using a climatarium or other similar equipment, the natural environmental conditions will be duplicated as nearly as possible.
   d. Because the two most obvious elements of the aquatic populations are algae and protozoans, these two general types will be counted with the hemocytometer counting chamber over a period of five weeks.
   e. The weekly counts will be tabulated on a chart similar to the following:

Date	Age of Culture	cells/cc Algae	Protozoa

   f. At the end of five weeks, the data will be graphed and analyzed.

(Continued)

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Audio–Visual: Community:	Classroom: (Continued) ANALYSIS: A. Explain weekly variations in the culture. B. Assuming that conditions were optimum at the onset of the experiment, explain any reductions in either population. C. Assuming that a natural carbon cycle is maintained between autotrophs and heterotrophs, predict the outcome of a similar experiment set up with either algae alone or protozoans alone. D. Which of the two populations appears to be independent and which appears to be dependent? E. Would changes in environmental conditions affect the carrying capacity of this closed culture? Suggest variables to test your hypothesis. Carry out the indicated experiments if time permits. F. Additional discussion concerning inhibitory effects of auto-toxins and waste products might be desirable.

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E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 4 - Water

SUBJECT Advanced Biology

ORIENTATION Water Use

TOPIC/UNIT Water Transport in Plants

BEHAVIORAL OBJECTIVES

Cognitive:

1. Demonstrate procedure for observing and quantitatively measuring the extent of water use in plants.
2. Determine water quality and algae concentration of local water sources.

Affective:

Demonstrate awareness of plant structures involved in water transport by diagramming and labeling the structure.
Demonstrate awareness of methods of testing water quality by listing several of them. Show his value of water testing by suggesting that it be done on given bodies of water as a way of determining water quality.

Skills Used:

Experimental techniques.
Data analysis.
Problem recognition.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Have students grow several bean plants. When plants are 2-3 inches tall, they should be treated and set up in test tubes according to diagram. Allow plants to stand in indirect light for 24 hours. Then determine the difference in millimeters between the original and final water levels. Remember to mark with a wax pencil original and final water levels.

   (Diagram on reverse side.)

Outside or Community:

1. Student can gather water samples from local streams or lakes. By use of La Motte or Hach kits, test for water quality. Then determine kinds and numbers of algae in water samples. Finally, have students attempt to explain the relationship between concentration of pollutants and algal growth.

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SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES

Publications:

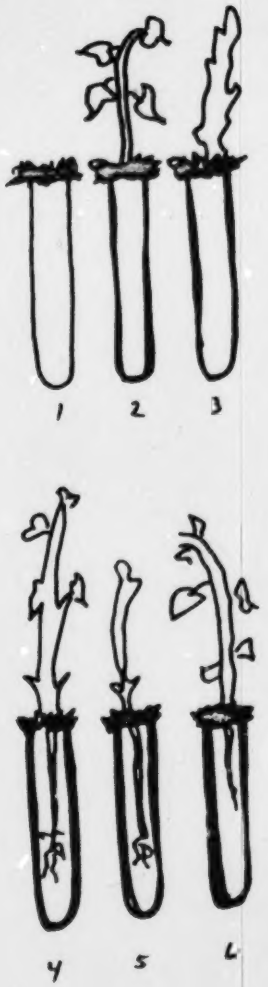
Biological Science, Molecules to Man, BSCS, Blue Version, 2nd Ed.
High School Biology, BSCS, Green Version, 2nd Ed.
Zimmermann, M. H., How Sap Moves in Trees, Scientific American, March, 1963, Offprint-154.
Water Pollution and Environmental Studies, Vol I-II, Environmental Protection Agency.

Audio–Visual:

Hach or LaMotte Kit.

Community:

Local streams or lakes.



E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

Integrated with:

CONCEPT NO. 5 - Air

SUBJECT Advanced Biology

ORIENTATION Microorganisms in Air *

TOPIC/UNIT Microbiology

BEHAVIORAL OBJECTIVES

Cognitive:

Explain the two principles upon which the determination of numbers and types of microorganisms is based. Determine kinds and numbers of microorganisms in various air samples.

Affective:

Demonstrate awareness of the microbiological factor involved in air quality.

Skills Used:

Millipore technique.
Bacteriological techniques.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Using a millipore filtration apparatus and a vacuum pump, students can sample quantities of air in various locations for microorganisms. Observation on varieties and direct counts can be used as data. Weather factors such as wind direction, wind velocity and humidity can also be obtained. Comparison of bacterial growth and weather factors provides for interesting relationships.

MEMBRANE FILTER METHOD

Materials needed:

Four membrane filters, 150 microns thick, 47 mm porosity 0.45 in sterile packets with pads.

Membrane filter holder sterile. (This will need to be sterilized before each collection period with an autoclave, if available. If not, by rinsing in 70% alcohol.)

One vacuum pump - electrical or water faucet aspirator.

(Continued)

Outside or Community:

SUGGESTED RESOURCES

Publications:

Microchemical and Instrumental Analysis, Pamphlet (free) Millipore Corp., Bedford, Mass.
BSCS, Green Version, High School Biology, 2nd Ed., Chapter 6.

Audio-Visual:

Film: Membrane Microfiltration, A New Tool for Classroom Science, free, Millipore Corp., Bedford, Mass. 01730.

Community:

Air samples - various locations.
Weather reports, TV, Radio.

CONTINUED OR ADDED LEARNING ACTIVITIES

In-Class: (Continued)

Four individual vials containing a total medium (nutrient).

The membrane filters are made of cellulose, 150 microns thick 47 mm in diameter .45 micron diameter pores and 80% of this area is perforated.

The precision of manufacture is such that bacteria larger than .47 micron cannot pass through. Most bacteria and all fungi are larger than this. The 80% perforation facilitates rapid filtration. When air is pulled through the filter by means of a vacuum pump, all the bacteria of interest will be retained on the filter's surface. They will be relatively evenly dispersed. The membrane filter is then placed on the absorbent pad saturated with liquid nutrient medium in individual vials and incubated 48 hours. The organisms on the filter disc will form colonies that can be counted directly or with the aid of a disecting scope.

1. Select a collection site away from an excessive air disturbance caused by people and safe from accidents.
2. Using sterile forceps flamed in a bunsen burner, carefully remove the membrane filter (thinest item) between blue sheets from its sterile packet. Don't touch with fingers, don't lay it on the table top. Leave thickest pad in a sterile packet. Carefully unscrew top part of filtration flask (membrane holder) and place it on the filter holder - make sure that it is centered and flat and then carefully replace the top back into position.
3. Attach one end of a rubber hose to a vacuum source (pump or water aspirator) and the other end to the filtration flask (membrane holder) located at the chosen site.
4. Turn on water or electricity and allow the vacuum pump or aspirator to pull air through the filter for 10 minutes in case of the vacuum pump and 1/2 hour in case of the aspirator. An aspirator is preferred - since the pump could possibly pull air through the filter sufficiently fast to damage the microorganisms.
5. Disconnect the vacuum source. Take the filtration flask into the building. Disinfect table top area. Proceed as follows:

(Continued)

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SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Audio–Visual: Community:	Classroom: (Continued) 5. a. With flamed forceps transfer the sterile absorbed pad left in the sterile packet to a sterile petri dish. (Don't completely uncover the petri dish; lift off just enough to put pad in, then replace cover.) b. Obtain a vial of liquid medium. Using a file-score the vial in the indented area. Break off the top and flame the fluid containing part of the vial at the top. (Pass over a bunsen burner flame once or twice quickly.) Quickly pour the medium into the petri dish, holding the cover as described above. c. With flamed forceps, transfer the membrane filter from the flask to the top of the pad in the petri dish (lined side up). d. Incubate the petri dish at 25° C (room temperature) for 24 to 48 hours. (Do not incubate upside down.) e. Count and record colonies as described above for the agar plates. f. Sterilize filter holder for next collection.

E. S. E. A. Title III – PROJECT I-C-E 59-70-0135-4

Environmental: **Integrated with:**

CONCEPT NO. C- Resources **SUBJECT** Advanced Biology

ORIENTATION Soil as Natural Resources * **TOPIC/UNIT** Soils and Plant Growth

BEHAVIORAL OBJECTIVES

Cognitive:

Demonstrate the procedure for testing soil nutrients including recording analysis and reporting findings of their soil tests. Explain the relationship existing between the results of the soil test and the quality of animal life and conditions of plants in the area.

Affective:

Seek to correct any misuse of land around the school used for plantings by testing soil to determine nutrients missing.

Skills Used:

Using research materials in analysis of soil.
Record and analyze laboratory results.

STUDENT-CENTERED LEARNING ACTIVITIES

In-Class:

1. Using a gallon jar, fill half full of soil and the remainder with water. Shake the jar vigorously and let settle. Then measure the layers of soil and figure your percentages on the layers.

Outside or Community:

1. Do research in library on soil types, textures (size classes for soil texture).
2. Demonstration of a soil profile. Take the students to an area in which a roadway is being put in or a home is being built. You must have two or more layers or horizon that differ in properties such as color, texture, structure, consistency, porosity, and chemical reactions.
3. Collect soil samples. Select certain areas for your samples (low area, hilly, wetland, etc.). Using plastic bags for your samples, take approximately 15 cm. of soil.
4. Texture analysis - Using a soil sieve, separate the soil particles as to size and then determine the size, weight and the percentage of each type of soil on the basis of weight.
5. Determination of PH. Take a 10 gr. sample of soil and mix 10 ml. of distilled H_2O. Then drain off excess.

(Continued)

SUGGESTED RESOURCES

Publications:

Various state publications on soil analysis.
Life in the Soil, David Premer, BSCS Lab Block.
Field Ecology, Edwin Phillips, BSCS Lab Block.
Field Guides, Peterson.
Soil Ecology, Andrews, I-C-E RMC, Prentice-Hall Pub.

Audio-Visual:

Filmstrip:
The Management of Soil, Ecology and Man Series, I-C-E RMC St 11.

Community:

CONTINUED OR ADDED LEARNING ACTIVITIES

Outside or Community: (Continued)

5. Use a short strip of PH paper and compare with color scale in 30 seconds. With the evidence you have found, what types of soils are acidic or alkaline?
6. Soil mineral analysis - Test your soil samples for nitrogen, sulfur, cholorine, calcium, sodium, carbon, and potassium. Determine the relationship between minerals and the living organisms.
7. Bring in an agricultural agent of your county for a discussion of farm soils and the problems involved.
8. If a small plot of land is available near the school, the soil can be tested and students can choose proper plants for growth in that plot and carry out their observations over a long period of time.

E. S. E. A. Title III – PROJECT I-C-E 59-70-0135-4

Environmental:

Integrated with:

CONCEPT NO. 7 - Land Use

SUBJECT Advanced Biology

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ORIENTATION Man's Role - Land Use *

TOPIC/UNIT Man in the Ecosystem

BEHAVIORAL OBJECTIVES

Cognitive:

Determine changes in land use and population density through use of maps and photographs having several dates over a given period of time but for the same areas.

Affective:

Criticize local land use changes that are ecologically unsound, thus demonstrating an appreciation of his natural resources.

Skills Used:

Calculation.
Measurement.
Road maps.
Photo information.

STUDENT-CENTERED LEARNING ACTIVITIES

In-Class:

1. Many old maps of local area (city, county, state) showing roads, streets, highways and parking places, residential and industrial sites, shopping centers, parks, etc. are to be brought to the classroom.
2. Make transparency overlays of identical areas, showing changes being made.
3. A transparency of a township can be used to calculate area devoted to roads, cities, etc. Compare older maps with most recent maps for linear miles of roads, square miles of cities, residential areas, agricultural areas, wildlife areas, etc.
4. Develop a list indicating changes, ex-residential, commercial, etc. and discuss social implications, increase in pollution, etc. of these changes.

Outside or Community:

1. Visit an area of poor land utilization and development and another area that is a well planned development. Compare the difference.
2. Visitation speaker from the office of city engineer to discuss some changes being proposed by the governing bodies.
3. Visit to local museum, library, or historical site to view photos, memorabilia and artifacts.

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications:	
Audio–Visual: Films: Transportation: Footpath to Air Lane, BAVI, #1931. Land Forms and Human Use, BAVI, #6327.	
Community: State Historical Society. Chamber of Commerce. Dept. of Natural Resources. Dept. of Public Instruction.	

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental:

CONCEPT NO. 8 - Values and Attitudes

ORIENTATION Man's Values

Integrated with:

SUBJECT Advanced Biology

TOPIC/UNIT Heartbeat

BEHAVIORAL OBJECTIVES

Cognitive:

Demonstrate a procedure for quantitatively determining the effect of several materials on heart rate in daphnia. Explain how a given value of man's can affect the heartbeat of a person.

Affective:

Appreciate the effects that certain household drugs and beverages have on heartrate in daphnia. Advocate the nonuse of stimulants and depressants except for specific situations and as prescribed by the physician.

Skills Used:

Use of microscope.
Data Analysis.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Obtain culture of daphnia. Have students place a daphnia on depression slide in water. Using a microscope, have one student count heartbeats and the other acts as a timer to determine heartbeats per minute. Repeat procedure using other substances such as tea, codeine phenobarbitol, coffee, alcohol, and tobacco solution. Have students record data and attempt to determine which substances were depressants or stimulants. For more detail observe (BSCS Blue Version, p. 770).
2. Have students discuss why man has developed the need for so many different varieties of depressants and stimulants in his life.

Outside or Community:

1. Depending on time of year, students can attempt to find their own daphnia in local streams and ponds.

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Biological Science: Molecules to Man, BSCS Blue Version, 2nd ed. The Delicate Balance, Gordon Harper & Row Pub., lac series. **Audio-Visual:** Heart - How It Works, BAVI. Heart and Circulation, BAVI. **Community:** Medical Doctor: use of drugs as source of medical help.	

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental: **Integrated with:**

CONCEPT NO. 10 - Economic Planning **SUBJECT** Advanced Biology

ORIENTATION Effect of salt on vegetative growth * **TOPIC/UNIT** Osmosis

BEHAVIORAL OBJECTIVES

Cognitive:

Students will correlate the physiology of movement across cell boundaries in organisms with the damage to organisms observed in field situations affected by road salts, by direct observation of lab tests and field examination.

Affective:

The student will realize that what sometimes economically seems to be the best method causes the greatest environmental loss.

Skills Used:

Collection and identification of roadside flora and fauna. Comparative analysis of data.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Discussion review of principles of diffusion in organisms.
2. Library research on the effects of salts on:
   a. aquatic and terrestrial plants
   b. aquatic and terrestrial animals.

Outside or Community:

1. Library research on possible substitutes for chlorides in ice melting.
2. Conduct standard "potato test" or other osmosis experiments showing dehydration by salt solutions.
   Potato Test:
   Use known length of cut fresh potato, e.g. 40 x 4 x 4 mm, immersed in solutions of varied strengths of salts, sugar, and other soluble diffusable substances. Remeasure after two hours.
3. Qualitative and quantitative survey of flora and fauna in:
   a. roadside known to be heavily salted
   b. roadside pond
   c. roadside stream
4. Survey of above a, b, and c in an area not near possible salting operations.
5. Publication of results in local newspaper with accompanying written articles attempting to influence the readers attitude concerning use of salt as a de-icer.

(Continued)

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Taxonomic Keys - Cray's Manual of Botany - Spring Flora of Wisconsin, by Norman Facett. Eddy, Samuel, Key to Fresh Water Animals of the North Central States. Giese, Cell Physiology. Texts on human and animal physiology. Field Guide - Audubon Society. BSCS Green Version, Lab Manual. **Audio-Visual:** **Community:**	Outside or Community: (Continued) 6. Invite speaker from county or city highway department. 7. Invite DNR Game Manager to speak to class, concerning effects of salt on roadside flora. General Rationale: This exercise reviews the principles of movement across cellular membranes by simple physical diffusion. It considers the effects of quantitative changes in concentrations of diffusable substances on the living cell and on the organism as a whole and then applies the principle to a practical situation.

E. S. E. A. Title III – PROJECT I–C–E 59–70–0135–4

Environmental: **Integrated with:**

CONCEPT NO. 11 - Individual Acts **SUBJECT** Advanced Biology

ORIENTATION Recycling * **TOPIC/UNIT** Conservation

BEHAVIORAL OBJECTIVES

Cognitive:

Orally solve problem and successfully alleviate the problem using approved conservation techniques when given an adverse situation such as accumulating trash. Record, analyze and report (orally) the findings and recommended solution(s) to speech class given a field activity.

Affective:

Positively propose solutions to the trash problem and attempt to influence the actions of the other students in school in speeches given to other classes.

Skills Used:

Computations of wastes and analysis of data.
Record, arrange, analyze and report of field trip activity.
Speech skills.

STUDENT–CENTERED LEARNING ACTIVITIES

In-Class:

1. Temporarily halt janitorial service in classroom (two weeks should be sufficient).
2. When trash becomes noticeable, have students catagorize and weigh it.
3. Discussion points:
   a. Prevailing waste?
   b. How to stem the tide of waste?
   c. Can certain types of waste be re-used?
   d. Is it possible, with a minimum of janitorial aid, to reverse the past two weeks waste accumulation?
   e. Weigh trash and calculate amount of trash per student.

Outside or Community:

1. Because the activity would invariably result in a conclusion that paper is the most common waste:
   a. visit local or nearby paper mill to study energy needed to produce monthly class consumption of paper. (Multiply by classes in school, by schools in city, by schools in the state.)
   b. Source of wood used to produce paper.
   c. Pollution produced by paper mill.
   d. Recycling possibilities.
2. Field trips to any of the following areas would reenforce the concept:
   a. Pulp forest-managed and mismanaged if possible.
   b. Recycling mill.
   c. Public incinerator, dump, landfill.
   d. Oral reports in speech classes (presented to noninvolved classes).
3. Use a camera to prepare a slide record of the trash accumulated.

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Teaching for Survival, Mark Terry, Friends of the Earth/Ballantine Book, New York, 1971. Man's Impact on Nature, J. A. Lauwerys, Garden City, N.J., 1969, Natural History Press. Speaking By Doing, National Textbook Co., Skokie, Illinois. **Audio–Visual:** Garbage, 15 min., CESA #9. Make slide - case study. Bulletin board display on trash. Junkdump, I-C-E RMC #310. **Community:** Speech teacher as resource and organizing aide. Local sanitation engineer or garbageman to speak on the solid waste problem.	

E. S. E. A. Title III – PROJECT I-C-E 59-70-0135-4

Environmental: **Integrated with:**

CONCEPT NO. 12 - Stewardship **SUBJECT** Advanced Biology

ORIENTATION Human Values Toward Environmental Issues *** TOPIC/UNIT** Human Behavior

BEHAVIORAL OBJECTIVES

Cognitive:

Construct, administer and analyze an attitudinal survey toward environmental issues presently being debated in local and state government. Describe several factors that must be taken into account when analyzing the data from the survey for an accurate determination of people's attitudes.

Affective:

Demonstrate awareness of other peoples' attitudes toward stewardship of the earth, by citing examples. Defend the idea that socio-economic groups are stratified in their response to pollution abatement.

Skills Used:

Survey Method.
Data Analysis.

STUDENT-CENTERED LEARNING ACTIVITIES

In-Class:

1. Have students, via a class discussion, make an attitudinal survey. Sample items could be questions concerning population, energy use, pollution abatement, quality of human living space, etc.
2. Students should administer survey to people in community. Can also administer to different age groups to add another dimension or different socio-economic groups.
3. Record results of survey and attempt to predict population attitudes about environmental issues. Have students discuss their survey results.

Outside or Community:

1. Students should administer survey to people in community. Can also administer to different age groups to add another dimension or different socio-economic groups.

SUGGESTED RESOURCES	CONTINUED OR ADDED LEARNING ACTIVITIES
Publications: Investigating Your Environment, BSCS, 1970. **Audio–Visual:** Film: Family Planning, Walt Disney, I-C-E RMC #230. Junkdump, I-C-E RMC #310. Men at Bay, King Screen Productions, 1971. Later, Perhaps. I-C-E RMC #290. **Community:** Administer survey to people in community.	